

**UCLA NUCLEAR MEDICINE SERVICE**

**ORIENTATION MANUAL FOR RESIDENTS**

Approved by Nuclear Medicine Quality Improvement Committee

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# **UCLA NUCLEAR MEDICINE SERVICE**

## **ORIENTATION MANUAL FOR RESIDENTS**

There are two main purposes for this manual...

first, to offer a 'crash course' for residents new to Nuclear Medicine, that will enable them to navigate through the most practical aspects of the General Nuclear Medicine and PT/CT rotations, from their first hour of their first day on the UCLA Nuclear Medicine service, including a few pointers intended to be useful in approaching and reporting the procedures and studies most commonly performed in Nuclear Medicine;

second -- beyond providing a set of answers, compiled in one convenient resource, to help residents address the kind of queries common to starting rotations through any imaging-based service (What are the main learning objectives for this rotation and expectations for my performance? Which workstation/display software do I use for this kind of study, and how do I use it? How do I reach whom about what? What should I be particularly aware of, when reporting studies for which I'm responsible on this rotation?) -- this manual may also serve as a lasting and living resource, to be repeatedly used and updated by its users, to check on any issues for which some additional practical guidance would be helpful, or for which a quick refresher would be desired.

To this latter end, I would ask everyone in the course of making use of this manual to please feel free to jot down any questions, comments, or suggestions for corrections, and additions that they would find helpful, and send to me in an email, with a "cc" to Amber Hain (for whom addresses can be found in the final two pages of this manual, devoted to "Contact Information"), so that they can be promptly responded to, and incorporated into the Manual for the benefit of its current and future users.

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## **INTRODUCTION TO NUCLEAR MEDICINE ROTATIONS AT DGSOM**

### **General**

Nuclear medicine is the medical specialty that uses radiotracers and radiopharmaceuticals, to evaluate molecular, metabolic, physiologic and pathologic conditions of the body using the tracer principle, and for the purposes of diagnosis, therapy, and research.

The specialty education of physicians to practice independently is through experience, and necessarily occurs within the context of the health care delivery system. Developing the skills, knowledge, and attitudes leading to proficiency in all domains of clinical competency, requires the resident physician to assume personal responsibility for the care of individual patients. The essential learning activity is interaction with patients under the guidance and supervision of faculty members who give value, context, and meaning to those interactions. As residents gain experience and demonstrate growth in their ability to care for patients, they assume roles that permit them to exercise those skills with greater independence. This concept--graded and progressive responsibility--is one of the core tenets of American graduate medical education. Supervision in the setting of graduate medical education has the goals of assuring the provision of safe and effective care to the individual patient; assuring each resident's development of the skills, knowledge, and attitudes required to enter the unsupervised practice of medicine; and establishing a foundation for continued professional growth.

### **Objectives, Tasks and Work-Flow in the NM clinic**

For radiology residents, the rotations through nuclear medicine are cumulatively four months in length. For UCLA residents there are 4 sites available, of which at least two need to be at the NM division in the DGSOM. This entails one month of general NM diagnosis and therapy, and one month hybrid imaging (PET/CT and SPECT/CT).

The rotations are progressive, starting with procedures immediately supervised by faculty, with increasing responsibility per week on service.

The rotations provide a balanced educational environment, with both in- and out-patients, all aspects of diagnostic and therapeutic procedures. Residents are expected to attend the morning lectures, guest lectures, and journal club, if they do not conflict with the mandatory radiology didactic series at noon, and Thursday afternoon.

Residents review the requests, and approve them by indicating the clinical protocol to be followed, and writing a prescription for the radiopharmaceutical. Prescriptions need a written name, signature, date and time.

After the technologist has performed the study, a resident reviews the images, quality, and need for any augmentations, or extra images.

The resident generates a 'wet' read after the procedure has been finalized. The images will be reviewed with the attending faculty, and the final report adapted, amended, and corrected as needed. The preliminary report will be sent to the reviewing attending for approval and sign off.

Topics and procedures in which the resident will be trained to gain experience:

1. Nuclear cardiology, exercise, and pharmacological stress, perfusion and function, and quantification (LVEF)
2. Thyroid imaging for benign and malignant disease
3. Bone imaging, including metastasis surveys, fractures, osteomyelitis, prosthesis loosening vs infection
4. Lung perfusion and ventilation
5. Gastro-intestinal imaging, GI bleed, liver-spleen, hepato-biliary, gastric emptying
6. Genito-urinary imaging, nephro-scintigraphy, GFR
7. Lympho-scintigraphy and lymph node mapping, breast cancer and melanoma
8. Receptor imaging, somatostatin, dopamine, dotatate, mibg
9. PET/CT imaging using FDG, FDOPA,  $^{11}\text{C}$ -Acetate,  $^{68}\text{Ga}$ -DOTATATE,  $^{13}\text{N}$ - $\text{NH}_3$ , etc., for neuro-, cardiac-, and oncologic applications
10. Infection & inflammation
11. Therapy with I-131 sodium iodide

With increasing proficiency, residents will work with increasing autonomy and provide clinic coverage, e.g. evaluate image quality and quality control of the studies performed by the technologists and assessing the need for images, pharmacologic augmentation, etc. In case of questions, the supervising attending faculty is always available.

Resident interpretation of the study and preparation of a wet read for discussion with the attending follows thereafter. Teaching is predominantly 'by example' under guidance of a nuclear medicine specialist.

### **Clinical duties, location, and times**

The clinic is located in the B-114 suite of the MP 200 building. Radiology residents are expected to report to the nuclear medicine clinic at 08:00am. Coverage will be provided so that residents can attend noon lectures and the Thursday didactic lectures. Time off should be arranged in advance with the residency coordinators Carole Barrinuevo and Soosan Roodbari. The attending of the week should be informed of any changes or absence in advance.

## **Additional resources**

Books:       The Requisites of NM by Ziessman et al., USA  
              Essentials of NM by Mettler & Guiberteau, USA  
              Clinical NM by Cook et al., UK  
              Diagnostic NM by Schiepers, EU  
              Molecular imaging and its biological applications by Phelps (**Blue Bible**)  
              Physics in NM by Sorenson & Phelps, USA

Websites for clinical guidelines, protocols and appropriateness criteria

SNMMI	<a href="http://www.snmmi.org">www.snmmi.org</a>	Society of NM
EANM	<a href="http://www.eanm.org">www.eanm.org</a>	European Association of NM
RSNA	<a href="http://www.rsna.org">www.rsna.org</a>	Radiological Society of North America
ESR	<a href="http://www.myesr.org">www.myesr.org</a>	European Society of Radiology

Faculty, staff, administrative personnel

## GENERAL PROCEDURES

- Sign the request (req.) for the upcoming studies (in the reading room in unsigned box).
- First thing in the morning look at the daily schedule on EPIC (EMR system) to be prepared for the day and look for consultations or treatments on the schedule.
- Viewing studies on ESOFIT: almost all studies can be viewed by double clicking except cardiac studies which need the special applications QPS and QGS. Make sure that the setting on the ESOFIT is as follows: STUDY NAME and Data BASE: ALL and study date: TODAY
- Viewing the study on LEO 1 and 2: It is almost the same except SPECT/CT can be viewed with these 2 stations. For viewing a brain study: highlight the study and click on the brain reorient application. For reviewing the other SPECT/CT studies such as Bone SPECT, Ind 111, oct SPECT, parathyroid SPECT, highlight the study and under UCLA WORKFLOW applications find Symbia SPECT/CT app and click on it.
- Neuro Q: Only one computer in the reading room is used for running Neuro Q. Find the patient's name on the running application, click on it, launch it with NeuroQ, then go to the QC tab and adjust the border of the image accept the border, next click on the following available options: Process→Rigid Registration→reformat → OK.
- OSIRIX: Mainly is being used for PET/CT. Sometimes a study will be sent to your Mac workstation. Then there is no need for uploading it. If not: Query→Type the MRN→find the study→ open up the study file→click on the tab with green center next to WB CT and PET corrected→ close the query page→go to main page→ highlight the CT and PET while holding Command and then return. For more than 1 study the process is the same except all the necessary files should be highlighted.

**Dictation of the study:** [see also "Essential Aspects of Report Writing," below.]

- Powerscribe. Everyone will have their own account but all templates are available after you log in. First go to the Shortcuts tab and click on it. Then go to the Shared tab. Here you will find a list of attendings and residents who have templates in powerscribe. Find the name of the physician you are interested in and click on it. This will bring up their templates. Copy as personal the template you want to use. You will have the option to change the name of the template and once saved it goes into your personal template tab for easy access.

- Alternatively the report can be made on EPIC. Please find Dr. Auerbach's template on EPIC under the smart phrases manager and make a personal copy of the template (after this it will be saved in your smart phrases). Find the patient under study history tab, click on it, find the correct NM open Acc# number, click on it and then you can enter the template from your saved template and adjust it correctly.
- Please note some studies are unreportable on Powerscribe such as XOFIGO treatment and consultation, thyroid consultation.
- There are some studies that need to be reviewed by a doctor before the patient D/C from the clinic such as a bone scan (may need an extra view or SPECT), all tumor imaging, thyroid studies, renal studies (with or without Lasix).
- Please note the cardiac PET, brain PET as well as bone PET will be read by the general nuclear medicine team. The charts can be found in the PET/CT completed study box on the reading room wall.
- If you are on call that evening, make sure to find out who the on call tech is in Westwood and Santa Monica before leaving.
- There are numerous calls to the reading room which are not related to patient readouts. You can redirect them to the proper location; a list of all numbers is posted on the cabinet above the phone (PET/NM scheduler, front desk, PET reading room, tech area, NM film librarian, etc.).

**PET/CT rotation:**

- Sign the request (req.) for upcoming studies. These are found in the reading room in unsigned box.
- Since most of our studies also have diagnostic CT at the same time a joint report of the PET and also CT from radiology department will be generated.
- The day before they are to be read in joint conference, we make a list of the cases that needs to be reviewed with the radiology department. (General rules for making the list: please add all left over cases from the previous day, add all BODY PET/CT scheduled patients up to noon in your schedule in EPIC. Do not include cardiac, Bone PET and brain studies).
- You are working with two computers at the same time. The Mac for OSIRIX as your viewing station and the PC for EPIC as well as Powerscribe for dictation.
- Dictation: we are sharing the accession number (ACC#) with Radiology, and they take the number first, so you will not have access to it. Therefore, create a virtual

ACC# for yourself, using any label you prefer (patient name, MRN) in Powerscribe, as follows:

*Go to the order tab and change the available tab to ADD. Then on the box of ACC# make any label that you want and click on dictate new report. Now you are using a virtual ACC# to be able to use powerscribe and use your template. When the report is ready to be sent to attending, please ask how he wants it sent. Some prefer a Word document and others prefer staff messages through EPIC. If accidentally approve a report you can undo this by going to reports→approved→locate the report→right click→unapproved. Then go back to your reports tab, it should be there.*

## QUICK GUIDE TO STUDIES COMMONLY PERFORMED AT UCLA

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### **ESSENTIAL ASPECTS OF REPORTING**

Templates for all studies are available in Powerscribe (search under SCHIEPERS) and in CareConnect (search under ALLEN-AUERBACH).

Please keep in mind that the written report is the primary mode of communication between the physician interpreting an imaging study and the referring physician. The content of this report not only influences patient management and clinical outcomes but also serves as legal documentation of services provided and can be used to justify medical necessity, billing accuracy, and regulatory compliance.

The “History” should include the patient’s age, gender, the indication of the study, prior biopsies and treatments (with dates) as well as specific questions raised by the referring MD. Gathering all the necessary information before reviewing the images is essential!

Please make sure the “Procedure” section of the report adequately reflects what was done.

The “Findings” should be an objective description without interpretation and include site, size/extent, and intensity of tracer uptake along with correlation of these findings with other available imaging and comparison to prior imaging if available.

The “Impression” should start with an identification of the study as normal vs. abnormal, as appropriate, and consist of an interpretation of the findings, rather than just a restatement of the findings. If a prior study is available worsening/improvement/stability of the findings should be part of the “Impression”. A differential diagnosis should be provided, if applicable. Be sure to answer the clinical question prompting the study, as far as possible. Documentation of communication of urgent or emergent findings to referring physician needs to be documented in the report.

Please write full sentences.

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## **BONE STUDIES**

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### **Procedure: STANDARD BONE SCAN**

**Background:** Imaging 2-3 hrs after i.v. administration of Tc-99m MDP, allows tracer to accumulate in areas of blastic activity (osseous sites of tumor, trauma, inflammation/infection, stress reactions, physiologic growth), and areas of calcification (e.g., thyroid cartilage, sites of prior soft tissue injury)

**Common Indications at UCLA:** Evaluate for osseous metastasis, inflammatory arthritis.

**Some Key Points to Keep in Mind:** Very sensitive, not very specific... radiographic correlation often may help to clarify findings. Before patient leaves imaging suite, determine whether such clarification may be assisted through SPECT/CT views.

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### **Procedure: 3-PHASE BONE SCAN**

**Background:** Imaging that begins coincident with i.v. administration of Tc-99m MDP (flow phase), immediately followed by a static image (blood pool phase), further followed by imaging as above (delayed phase).

**Common Indications at UCLA:** Evaluate for osteomyelitis, complex regional pain syndrome.

**Some Key Points to Keep in Mind:** More specific than STANDARD BONE SCAN for these indications, but not specific for osteomyelitis in the setting of prior local trauma (e.g., diabetic foot), for which a Tc-99m WBC study is a better initial choice. Positive criteria for osteo include increased focality and intensity in bony structures with each phase. Positive criteria for crps are highly dependent upon time course, so be sure to get history of initial injury precipitating syndrome (when known), and how long symptoms have been present.

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## **BRAIN**

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### **Procedure: REGIONAL CEREBRAL METABOLISM, [F-18]FDG WITH PET/CT**

**Background:** Imaging 30-40 mins after i.v. administration of FDG allows tracer to accumulate in areas of greatest synaptic density and activity, for neurologic/psychiatric –indicated studies; imaging at least 60 mins after i.v. administration of FDG allows tracer to accumulate in the highest grade brain tumors (e.g., glioblastoma, melanoma, lymphoma) at levels even higher than normal cortical levels. Studies should be acquired with patients having eyes open in a dimly lit, quiet room.

**Common Indications at UCLA:** Evaluate for dementia symptoms, neurosurgical candidacy for treatment-resistant epilepsy, high-grade previously irradiated brain tumors.

**Some Key Points to Keep in Mind:** Very sensitive for neurologic/psychiatric indications; disease specificity, however, comes not from the underlying biochemistry of the radiotracer, but from the particular pattern of regional distribution, for those diseases where that would be highly characteristic (e.g., early-stage neurodegenerative dementing processes).

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### **Procedure: REGIONAL CEREBRAL PERFUSION, WITH SPECT**

**Background:** Because of the ability of brain tissue to tightly autoregulate vascular supply to match metabolic demands (except in the case of primary cerebrovascular diseases), principles of acquisition and interpretation are very similar to those employed with FDG-PET described above. However, spatial resolution is substantially worse, not only because of instrumentation differences, but also because perfusion changes and abnormalities are generally less well-localized than metabolic ones.

**Common Indications at UCLA:** Because of the considerations noted in Background above, the only indication for which brain SPECT is commonly employed at UCLA is pre-surgical planning for epilepsy patients, since the logistics of obtaining an ictal study are simplified with radiotracers having half-lives greater than those typical for PET radiotracers. These ictal SPECT studies are coupled with interictal SPECT studies, which are then used in SISCOM (subtracted ictal-interictal studies coregistered and overlaid upon MRI) analyses processed in the Neuroradiology suite.

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## **CARDIAC STUDIES**

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### **Procedure: MYOCARDIAL PERFUSION SCAN (RESTING ONLY)**

**Background:** Imaging performed after the injection of generally 15 mCi of 99m Tc-Myoview. Resting only study is often performed immediately (10 to 15 minutes) after i.v. administration of Tc 99m Myoview. Resting gated perfusion scan evaluates left ventricular perfusion, ejection fraction and wall motion during rest.

**Common Indications at UCLA:** Rarely performed as a separate test. Frequently performed in association with FDG PET myocardial viability study and FDG PET cardiac sarcoidosis study.

**Some Key Points to Keep in Mind:** The resting perfusion scan only assesses the resting myocardial blood flow. Normal resting myocardial perfusion scan can exclude significant myocardial infarct. Please note that myocardial ischemia is not excluded. Stress study is needed to exclude presence of ischemia.

When performed in association with FDG PET myocardial viability study, assess for resting perfusion defect and evaluate for perfusion/metabolism mismatch with FDG-PET study. The presence of resting perfusion defect and normal/increased metabolism corresponding to the perfusion defect suggests severely ischemic but viable myocardium.

When performed in association with FDG PET cardiac sarcoidosis study, assess for focal areas of hypermetabolism in the myocardial wall. The corresponding regions on the resting myocardial perfusion scan may or may not show significant perfusion defect.

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### **Procedure: MYOCARDIAL PERFUSION SPECT SCAN - RESTING STUDY FOLLOWED BY STRESS STUDY (MOST FREQUENTLY PERFORMED)**

**Background:** Resting perfusion images performed after the injection of 0.114 mCi/kg of 99m-Tc Myoview. This is followed with a stress study. The stress study may be treadmill stress test or pharmacological stress test. At peak stress (as listed below) the patient receives intravenous injection of 0.357 mCi/kg of 99m Tc-Myoview. This is followed by stress gated myocardial perfusion scan.

**Common Indications at UCLA:** Evaluate for myocardial ischemia.

**Some Key Points to Keep in Mind:** Normal rest/stress myocardial perfusion scan excludes significant ischemia. Reversible myocardial perfusion defect (perfusion defect on stress images with normal perfusion on the rest images) suggests myocardial ischemia. Fixed myocardial perfusion defect (defect seen on both stress and rest images) suggests myocardial infarct. This perfusion defect may also show hypokinesia/akinesia on the gated left ventricular wall motion study.

Assess for attenuation related artifacts prior to evaluation of myocardial ischemia. The common attenuation related artifacts include diaphragmatic attenuation, breast and body habitus attenuation. These defects could be fixed or reversible. Assess gated wall motion along with the perfusion study.

Note that significant patient motion during image acquisition can also lead to artifactual defects.

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### **Procedure: TREADMILL STRESS STUDY**

**Background:** Please review the requisition for the study. Assess patient's capability to ensure that adequate treadmill stress level - Bruce protocol stage III (10 mets) can be attained. Please ask the patient if he/she can climb 2 flights of stairs without getting significant shortness of breath. The patient is asked to exercise to maximum exercise tolerance. Please note that target heart rate is not the end point. Please note that the stress isotope injection must be performed at least one minute prior to the termination of the treadmill stress test.

**Common Indications at UCLA:** Preferred method for stress testing among patients with adequate exercise tolerance and mobility.

**Some Key Points to Keep in Mind:** Review patient's history. Review patient's medications. The patient on higher doses of beta blocker or calcium channel blockers may not achieve target heart rate.

Patients with left bundle-branch block on resting ECG are often converted to Lexiscan stress test, because of the greater incidence of artifacts with rate acceleration.

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### **Procedure: LEXISCAN STRESS STUDY**

**Background:** Please review the requisition for the study. Pharmacological stress test is done in patients unable to perform treadmill stress test, and liver transplant pre-ops. Please ensure that aminophylline injection is available prior to the Lexiscan study. Fixed dose Lexiscan injection (0.4 mg) is administered intravenously from 0 to 20-30 seconds. This is followed by intravenous 99m-Tc Myoview at approximately 60 seconds.

**Common Indications at UCLA:** Preferred method for pharmacological stress testing.

**Some Key Points to Keep in Mind:** Review patient's history and medications. Assess for history of bronchospastic respiratory disease prior to the stress test. Make sure that the patient has not had coffee/caffeine for at least 12, and preferably 24, hours. Examine baseline EKG. Patients with history of active asthma or significant bronchospasm associated with COPD may be converted to dobutamine stress study. Second or third degree AV block is an *absolute contraindication* against Lexiscan infusion. Please check with referring physician prior to conversion to dobutamine stress study.

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**Procedure: DOBUTAMINE STRESS STUDY**

**Background:** Please review the requisition for the study. Dobutamine stress test is generally reserved for patients unable to perform treadmill stress test and for whom Lexiscan is contraindicated. Dobutamine is given in incremental doses of 10 mcg/kg per minute, 20 mcg/kg per minute, 30 mcg/kg per minute and 40 mcg/kg per minute, increasing every 3 minutes.

The Myoview stress injection is performed at or near target heart rate or after the completion of maximal infusion rate. If the target heart rate is not reached, either the Myoview injection is still performed (if the patient's heart rate is close to the target heart rate) or the patient's heart rate can be further increased by giving intravenous 0.2-0.5 mg atropine.

**Common Indications at UCLA:** Less preferred method for pharmacological stress test. Only performed in patients who are unable to do treadmill stress test and for whom Lexiscan is contraindicated (see above).

**Some Key Points to Keep in Mind:** Patients who are on beta blockers may not achieve target heart rate. Encourage the patient to report significant chest pain as it may be symptom of myocardial ischemia.

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**Procedure: MYOCARDIAL PERFUSION PET/CT SCAN - RESTING STUDY FOLLOWED BY STRESS STUDY**

**Background:** Resting perfusion images performed after the injection of N-13 ammonia. This is followed with a pharmacological stress study with adenosine, infused slowly over 4 minutes using a pump. There stress N-13 ammonia dose is administered after 2 minutes into adenosine infusion. This is followed by stress gated myocardial perfusion PET/CT scan.

**Common Indications at UCLA:** Evaluate for myocardial ischemia.

**Some Key Points to Keep in Mind:** Adenosine infusion may also cause marked shortness of breath in patients with history of asthma or bronchospastic COPD and is not performed in these patients if active wheezing can be heard on stethoscopic exam. Second or third degree AV block is also an *absolute contraindication* against adenosine infusion. The PET/CT study provides higher resolution images compared to SPECT myocardial perfusion scans. The other advantages include available attenuation correction and quantitative myocardial blood flow assessment.

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## **PROCEDURE: FDG PET SCAN FOR EVALUATION OF CARDIAC SARCOIDOSIS**

**Background:** The study is performed to evaluate for active sarcoidosis. The patient must fast for approximately 16 hours prior to the FDG injection. Whole-body PET/CT scan without IV contrast is also performed. Low dose attenuation correction CT protocol is used. This is followed by dedicated cardiac FDG PET scan. A resting Myoview perfusion SPECT scan or a resting N-13 ammonia PET/CT scan is performed prior to the FDG PET scan.

**Common indications at UCLA:** Patients with recurrent or malignant ventricular arrhythmias. Occasionally patients with cardiomyopathy and ventricular arrhythmias.

**Some Key points to keep in mind:** Exclude the presence of coronary artery disease, preferably with the prior coronary angiogram. There is physiologic FDG uptake in the myocardium even after prolonged fasting. This can substantially limited evaluation of focal active sarcoidosis.

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## **Procedure: FDG PET SCAN FOR EVALUATION OF MYOCARDIAL VIABILITY**

**Background:** A resting Myoview perfusion SPECT scan or a resting N-13 ammonia PET/CT scan is performed prior to the FDG PET scan. FDG-PET CT scan is then performed to evaluate resting perfusion defect to assess for myocardial viability in that region.

**Common indications at UCLA:** Assessment of myocardial viability.

**Some Key points to keep in mind:** The myocardial viability study is only performed if a resting myocardial perfusion defect is noted. The myocardial perfusion/metabolism mismatch is generally considered the gold standard for assessment of viability of the myocardial tissue.

[Rarely, and primarily only in the case of unavailability of PET, a myocardial viability assessment is performed using Tl-201 Chloride resting/redistribution protocol: resting perfusion myocardial SPECT study is performed after intravenous injection of 4 mCi of

thallium 201 chloride. A 24 hour redistribution myocardial perfusion SPECT study is then performed. Viable myocardium shows significant redistribution corresponding to the resting myocardial perfusion defect.]

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## **NUCLEAR ENDOCRINE STUDIES**

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### **Procedure: THYROID UPTAKE AND SCAN**

**Background:** Imaging 6 and 24 hrs after ingestion of a capsule with 0.2 mCi I-123 sodium iodide. The iodide is accumulated in the thyroid gland and organified, i.e. built in the T3 and T4 hormones. The normal uptake at 24 hr in Southern California is 20-30%

The distribution of uptake may indicate areas of hypo- or hyperfunction such as in nodular goiter, or diffuse hyperthyroidism as in Graves' disease. Focal nodules may represent thyroid cancer.

**Common Indications at UCLA:** Evaluate hypo- or hyperthyroidism. Evaluate type of nodule: cold, cool, warm, or hot.

**Some Key Points to Keep in Mind:** Sensitive test. Resolution of planar imaging is improved by using pinhole collimation. Keep interference of iodide uptake with diet and medications in mind. A short interview with the patient is necessary to inquire about food, diet, and medications. Before patient leaves imaging suite, determine whether SPECT/CT imaging is needed.

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### **Procedure: SURVEILLANCE SCAN AFTER TREATMENT OF DIFFERENTIATED THYROID CA**

**Background:** Imaging 24 hrs after ingestion of a capsule with 5 mCi I-123 sodium iodide. The iodide is accumulated in the remnant thyroid and differentiated, i.e. still having the capacity to produce T3 and T4 hormones, thyroid cancer. Patients are typically prepared with 2 intramuscular injections of 0.9 mg rhTSH (recombinant human thyrogen), 1 day and 2 days before ingesting the capsule.

A dedicated neck scan in the anterior position, and a whole body scan in anterior and posterior views are acquired.

Imaging at later time points may be obtained, as needed.

**Common Indications at UCLA:** Evaluate thyroid cancer recurrence.

**Some Key Points to Keep in Mind:** this test has many false positive, which need to be checked off carefully. Resolution of planar imaging is 1-2 cm. SPECT/CT imaging is helpful in differentiation esophagus or muscle uptake from metastatic nodes.

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## **GASTROINTESTINAL STUDIES**

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**Procedure:** GASTRIC EMPTYING

**Background:** Imaging of tracer labeled food emptying from the stomach.

**Common Indications at UCLA:** Evaluation of suspected gastroparesis.

**Some Key Points to Keep in Mind:** Normal value for UCLA protocol is 50% or more emptying of a solid meal at 90 minutes. At age 3 emptying dynamics pediatric emptying dynamics are similar to adults. No normal values for liquid meals or population <3 years.

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**Procedure:** GI-BLEED

**Background:** Imaging after injection of Tc-labeled RBCs can help identify sites of bleeding.

**Common Indications at UCLA:** Suspected GI-bleed, pre-surgical or pre-IR intervention.

**Some Key Points to Keep in Mind:** Only active bleeding can be identified (minimum rate 0.1ml/min vs angiography 0.5ml/min). Best reviewed in cine mode. An active bleed will move in anterograde and/or retrograde pattern (blood is a strong peristaltic agent). Anatomic site localization roughly limited to SB vs colon (asc/hepatic flexure/transverse/splenic flexure). This allows selective angiography of the intestinal blood vessels. Penile blood flow can be confusing (obtain lateral image for clarification).

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## **GENITOURINARY STUDIES**

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### **Procedure: MAG 3 RENAL SCAN**

**Background:** Imaging of renal function, and, in the setting of suspected obstruction, the response to a diuretic.

**Common Indications at UCLA:** Hydronephrosis on anatomical imaging (US, CT,...)-rule out obstruction. Special indications in the transplant setting (ATN, urinary leak,...).

**Some Key Points to Keep in Mind:** Look at the actual images before assessing curves, which are very dependent on ROI drawing. If there is no tracer collection in the renal pelvis region on initial images, there is no obstruction and no need for Lasix and additional imaging.

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### **Procedure: DMSA RENAL SCAN**

**Background:** Imaging of the renal cortex by using a tracer (DMSA) that binds to the renal tubules.

**Common Indications at UCLA:** Evaluation of scarring in pediatric patients with acute of chronic pyelonephritis.

**Some Key Points to Keep in Mind:** The images show distribution of functioning tissue in the kidney. Acutely infected or scar tissue does not take up the tracer. This scan is not useful for evaluation of renal perfusion and function or the work up of hydronephrosis.

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**Procedure: LUNG – PULMONARY PERFUSION AND VENTILATION**

**Background:** Wedge-shaped peripherally based perfusion defects are compatible with, though not entirely specific for, acute pulmonary embolism, and are also a reasonably sensitive measure, for embolic defects of adequate size. When seen, it is necessary to derive specificity of interpretation from comparison with radiographic (CXR or chest CT) and/or scintigraphic (pulmonary ventilation) studies.

**Common Indications at UCLA:** Unexplained shortness of breath, tachycardia, blood oxygen desaturation.

**Some Key Points to Keep in Mind:** While reasonably sensitive, such that an entirely negative study provides a high level of assurance that no clinically significant pulmonary embolism is present, the specificity of the study relies upon a skilled interpreter to correlate perfusion results positive for suspicious defects, with adjunctive studies as mentioned above. PIOPED, modified PIOPED, PISAPED, and other interpretive criteria may be employed, but no outcome evidence exists for the accuracy of a skilled interpreter benefiting from any particular criteria set, versus using no systematic scheme at all (“gestalt” method of interpretation).

[NOTE: For all V/Q scans ordered for the indication of evaluating for presence of acute pulmonary embolism, regardless of whether the interpretation of the study is positive or negative, please document in the report that the referring physician was contacted with the result, as V/Q studies are being followed in our Division as an index of adequacy of documentation of reporting of results for critical studies.]

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**NUCLEAR ONCOLOGY STUDIES**

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**Procedure: SCAN AFTER TREATMENT WITH HIGH DOSE I-131**

**Background:** Imaging is performed 5 days (stimulation protocol) or 7 days (withdrawal protocol) after treatment with I-131 sodium iodide.

The iodide is accumulated in differentiated cancer. If the cancer has dedifferentiated, the iodine scan will become negative. If the thyroglobulin increases, this indicated recurrence, and a non-specific tracer such as FDG is indicated to diagnose recurrence and/or metastasis.

A dedicated neck scan in the anterior position, and a whole body scan in anterior and posterior views are acquired.

SPECT/CT imaging may be indicated to resolve location and anatomical correlation of lesions.

**Common Indications at UCLA:** Evaluate distribution in the body with thyroid cancer involvement, i.e. remnant, regional and/or distant metastasis.

**Some Key Points to Keep in Mind:** There are many false positives, which need to be checked off carefully. Resolution of planar imaging is 2-3 cm. SPECT/CT imaging is helpful in differentiating and localizing lesions.

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### **Procedure: PARATHYROID IMAGING**

**Background:** Planar imaging is performed approx. 10 and 90 min after IV administration of 22 mCi of Tc-99m SestaMIBI. SPECT-CT of the neck is acquired at 60 min. Additional views are optional.

Primary hyperparathyroidism is caused by a parathyroid adenoma in approx. 85% of patients. The study is indicated for **localization** only. It is not indicated to reveal the source of hypercalcemia. It helps the endocrine surgeon in planning the procedure.

The washout of tracer is slower from parathyroid tissue compared to thyroid tissue.

**Common Indications at UCLA:** Evaluate presence and number of parathyroid adenomata.

**Some Key Points to Keep in Mind:** Report the location of the focus of persistent activity. On CT the focus should be associated with a soft tissue density. CT permits to distinguish lymph nodes from nodules.

The visualized lungs can be inspected for pulmonary nodules. If one is found a diagnostic CT with fine cuts may be recommended.

Thyroid adenomas cannot be distinguished from parathyroid adenomas. In that case, a thyroid pertechnetate scan is recommended to diagnose a thyroid adenoma.

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**Procedure: PENTETREOTIDE IMAGING**

**Background:** Planar and SPECT-CT imaging is performed 4 hrs, 1 and 2 days after IV administration of 6 mCi In-111 pentetretotide. The patient should be off short-acting somatostatic blockers for 24-48 hrs.

Pentetretotide visualized somatostatin receptor subtype 2 bearing tumors. The multiple acquisitions are performed to evaluate physiologically excreted tracer inside the bowels.

**Common Indications at UCLA:** Neuroendocrine tumors

**Some Key Points to Keep in Mind:** Report the location of the abnormal tracer collection(s). Use SPECT-CT for proper localization inside the body in 3D.

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**Procedure: MIBG IMAGING**

**Background:** Planar and SPECT-CT imaging is performed 24 hrs after IV administration of 10 mCi I-123 MIBG. There is a 2 page list of interfering medications. This list should be checked **before** scheduling the test and ordering the radiopharmaceutical. The patient should be off short-acting somatostatic blockers for 24-48 hrs.

The thyroid of the patient must be blocked with potassium iodide p.o. 1 hr before administration of the radiopharmaceutical.

**Common Indications at UCLA:** Diagnosis and monitoring of pheochromocytoma, neuroblastoma.

**Some Key Points to Keep in Mind:** If the heart does not have uptake, a false negative scan may be suspected; no uptake means that the cardiac receptors are blocked or occupied. NET may be better imaged with FDOPA (not an FDA-approved indication).

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**Procedure:** PET/CT

**Background:** PET/CT Imaging after i.v. administration of a PET tracer (mostly FDG; other tracers include 68Ga-DOTATATE, F-DOPA, 11C-Acetate, 13-N-NH3)

**Common Indications at UCLA:** Oncology, Neurology (epilepsy, dementia), Cardiology (CAD, viability)

**Some Key Points to Keep in Mind:** Knowing the biodistribution of the tracers used is essential for correct image interpretation. Oncologic scans are discussed with Radiology during daily PET/CT conference usually around 3.30pm. None of the tracers are entirely specific for malignancy.

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**Procedure:** SENTINEL NODE STUDIES FOR BREAST/MELANOMA

**Background:** A small amount of 99mTc labeled sulfur colloid is injected in the region of the breast cancer to facilitate the intraoperative identification of sentinel nodes.

**Common Indications at UCLA:** Breast cancer, Melanoma

**Some Key Points to Keep in Mind:** Breast injections are performed by NM physicians (melanoma injections by NM techs). Sentinel node tracer uptake does not mean the cancer has spread. If the referring MD is Dr. Economou, please page him with the location of the SNL asap.

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