Nuclear Medicine Protocols

Bone Scan

Isotope:
99mTc Medronate (MDP)

Adult Dose:
25 mCi

Indications:
Tc99m MDP may be used as a bone-imaging agent to delineate areas of altered osteogenesis. Indications include:

- Screening of high-risk patients with tumors (e.g. breast, prostate, lung, or kidney) known to metastasize frequently to bone.
- Detection of early osteomyelitis
- Detection of early avascular necrosis
- Detection of stress fractures and other occult skeleton trauma
- Detection and evaluation of Paget's disease, metabolic bone disease, and other osteopathy's
- Detection and evaluation of arthritis and internal joint derangements
- Evaluation of bone viability when blood supply is in question
- Evaluation of bone and joint pain of obscure origin
- Evaluation following an elevated alkaline phosphatase level
- Evaluation following questionably abnormal skeletal radiographs
- Serially following the course of bony response to therapeutic regimens (e.g. radiation therapy, chemotherapy, antibiotic therapy,)
- Diagnosis of reflex sympathetic dystrophy

Bone flow, SPECT, bone marrow, and bone indium studies may be performed in conjunction with a bone scan.

Patient Prep:

- Drink 2 - 4 : 8 oz of water and urinate often.

Exam Time:

- Initial injections: 15 min (Flow if necessary for 2 minutes, followed by immediate and 10 minutes static pictures.)
- 3 hour delayed imaging – SPECT Study may be performed on the 3-hour visit

Equipment and Energy:

- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 15% window

Protocol:

- Begin imaging 3 hours post injection of radiopharmaceutical
- Have patient empty bladder immediately prior to imaging
- Image supine with head out the whole body or area of interest
- Table motion of 10-15 cm/min
- Acquire anterior and posterior images as needed with a Spot or Static image as indicated
- On whole body imaging, always include lateral skull statics

Processing:

- Annotation for image identification, label as necessary
- SPECT- Reconstruct transverse, sagittal and coronal images

Bone Marrow Scan

Isotope:
99mTc Sulfur Colloid

Adult Dose:
10 mCi

Indications:
- Used in conjunction with Bone Scan and/or Bone indium to determine pathologies of the Bone marrow (See attached list for variation on bone imaging)

Patient Prep:
- None

Exam Time:
- Initial Injection – 15 minutes
- 15 – 20 minute scan time post injection.

Equipment and Energy:
- Gamma camera: Dual head, large field of view, LEAP parallel whole collimator.
- Energy: 140 keV with a 20% window

Protocol:
- Begin imaging 30 minutes post injection of radiopharmaceutical
- Acquire anterior and posterior images as needed with a Spot or Static image as indicated
- Image same views as bone scan

Processing:
- Annotation for image identification, label as necessary

Note - When doing bone marrow scan in conjuction with bone indium, draw 50cc's of patient's blood first to send to the radiopharmacy to be labeled.

Indication/Diagnosis	Appropriate Scan to Order
1. Stress Fracture	1. Three Phase Bone Scan
2. Prosthesis Loosening with NO mention of infection	2. Three Phase Bone Scan
3. Reflex Sympathetic Dystrophy	3. Three Phase Bone Scan
4. Osteomyelitis/Infection a) NO prosthesis or hardware b) NO recent surgery or debridement at site of possible infection	4. Three Phase Bone/ ^{111}IN Scan - 2-day exam with 3 patient visits
5. Osteomyelitis/Infection a.) WITH prosthesis or hardware b) Recent surgery or debridement at site of possible infection	5. Three Phase Bone/ ^{111}IN Scan WITH Bone Marrow Scan 2-day exam with 4 patient visits
6. Osteomyelitis/Infection vs. LOOSENING a.) WITH prosthesis or hardware b) Recent surgery or debridement at site of possible infection	6. Three Phase Bone/ ^{111}IN Scan WITH Bone Marrow Scan 2-day exam with 4 patient visits
7. Charcot Joint	7. Three Phase Bone/ ^{111}IN Scan WITH Bone Marrow Scan 2-day exam with 4 patient visits
8. PARS Defect	8. Bone Spect
9. Spondylolysis	9. Bone Spect
10. Bony Tumor	10. Bone Spect
11. Bone Metastases	11. Bone Scan Whole Body
12. Benign + malignant bone lesions	12. Bone Scan Whole Body
13. Padgett's Disease	13. Bone Scan Whole Body
14. Osteomyelitis of Spine	14. Gallium Scan 4-day test with 4-5 visits

Bone Indium Scan

Isotope:
Indium-111 labeled White Blood Cells - tagged by radio-pharmacy

Adult Dose:
500 uCi

Indications:
- Osteomyelitis
- Infection
- Loosening of prosthetic joint

(See attached list for variation on bone imaging)

Patient Prep:
- None

Exam Time:
- Day one:
  - 1st visit - 20 minutes (Draw 50cc of patient's blood to send to pharmacy)
  - 2nd visit – 20 minutes (re-inject patients' blood that is tagged with Indium-111
- Day two
  - 1st visit – 20 minutes to inject MDP and flow the images for the bone scan
  - 2nd visit – 40 – 60 minutes to image patient

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Medium Energy Collimator
- Energy: 171 and 245 keV with a 20% window for Indium
  140 keV with a 20% window for Tc

Protocol:
- Image patient supine taking same static images that were acquired for the bone marrow and bone scan
- Take 10 min static images

Processing:
- Display bone Tc and in pictures side by side and label them appropriately.

Bone SPECT

Isotope:
99mTc Medronate (MDP)

Adult Dose:
25 mCi intravenous

Indications:

- Tc99m MDP may be used as a bone-imaging agent to delineate areas of altered osteogenesis. Indications include:
- PARS defect
- Spondylolysis
- To evaluate fractures due to bone trauma

Bone flow, SPECT, bone marrow, and bone indium studies may be performed in conjunction with a bone scan.

(See attached list for variation on bone imaging)

Patient Prep:

- None, although hydration does improve the quality of images

Exam Time:

- SPECT Study may be performed on the 3-hr. visit: 45 minutes

Equipment and Energy:

- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window
- Collimator - LEHR

Protocol:

- Begin imaging 3 hours post injection of radiopharmaceutical
- Have patient empty bladder immediately prior to imaging
- Image supine with head out the whole body or area of interest
- Degree of rotation – 180 x 2 heads = 360 degrees
- Number of images 32 x 2 heads for a total of 64 images
- Time of imaging: 25 seconds/image
- Matrix: 128x128, mode: step and shoot, clockwise

Processing:

- SPECT- Reconstruct transverse, sagittal and coronal images
- Butterworth filter.

Brain Perfusion

Isotope:
99mTc ECD (Neurolite), 99mTc HMPAO (Ceretec)

Adult Dose:
30 mCi

Indications:
- Neurolite and Ceretec diffuse across the intact blood brain barrier in proportion to regional blood flow. This study provides information about regional cerebral blood flow and function which is not obtainable by CT/MR.
- Brain Death, Cerebrovascular Disease: Acute Stroke, Chronic Stroke, TIA, Dementia (to distinguish Alzheimer's from other dementia), Head Trauma, Epilepsy, Psychiatric disorders, Infectious processes, Degenerative Cortical processes.

Patient Prep
- IV access must be obtained before starting the procedure
- Patient cannot move or speak during the exam

Exam Time:
- 1 hour

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window

Protocol:
- Flow may be taken to establish blood flow to the brain.
- Image patient supine with head in special holder that is secure with Velcro
- Flex the head so that the cerebellum is included in the field of view

  SPECT may be performed.

Processing:
- Label all images appropriately
- Reconstruct transverse, sagittal, and coronal images if SPECT was performed.

Optional Maneuvers:
- Fast acquisition methods may be used in patients who are unable to hold still for prolonged periods of time.
- Seizures may be produced pharmacologically with Pentylenetetrazol for ictal imaging.
- Acetazolamide may be used to increase the sensitivity of brain perfusion imaging for cerebrovascular ischemia
    - Contraindications – allergy to sulfonamide
    - Side effects occur in about 50% of patients and last about 15 minutes; side effects include numbness around mouth or fingers, lightheadedness or blurred vision, flushed feeling around face and neck.
    - Inject 1 gm of Acetazolamide IV over 1-2 minutes
    - Wait 25 minutes and the inject pharmaceutical
    - Wait 20 minutes and acquire images in the usual manner
    - A baseline brain perfusion study without Acetazolamide is performed one or more days later.
    - Adenosine or Dipyridamole may be used instead of Acetazolamide

Cisternography

Isotope:
Indium-111 DTPA

Adult Dose:
1.0 mCi or 1.5 mCi

Indications:
- Visualization of flow patterns of spinal fluid
- Detection of CSF leaks
- Evaluation of function of surgical shunts
- Diagnosis of normal pressure hydrocephalus

Patient Prep:
- Informed consent must be obtained before lumbar puncture.

Exam Time:
- Initial lumbar puncture – 30 minutes performed by physician
- Delayed images at 2, 6, and 24 hours post injection – 30 minutes for each set of images
- Images may be needed at 48 and 72 hours post injection

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Medium Energy Collimator
- Energy: 171 and 245 keV with a 20% window

Protocol:
- Acquire an immediate spine static after injection
- Acquire a Posterior lumbar spine image at 2 hours
- Acquire Anterior and Left Lateral images at 2, 6, and 24 hours
- Acquire each image for 200 K counts
    - If at 2 hours there are very few counts coming from the head, show the image to the nuclear radiologist to determine if the injection extravasated outside the subarachnoid space. If there has been extravasion, the study is to be terminated.

Processing:
- Label images appropriately

Optional Maneuvers:
- Quantitative diagnosis of CSF rhinorhea:
- 2 hours after intrathecal injection of the radiopharmaceutical, anterior and posterior pledgets are placed in each nostril by an ENT physician.
- Each pledget is approximately 1 cm square, has the absorptive capacity of 0.5 mL of water, has a string attached for removal, and has a label on the string indicating its position.
- 4 hours after placement (6 hours post injection) the pledgets are removed
- 5 mL of venous blood is withdrawn into a heparinized tube at both insertion and removal of pledgets
- 0.5 mL of plasma is withdrawn from each blood sample after centrifugation
- The radioactivity in each pledget and plasma sample is measured in a well counter using a 150-250 keV energy window
- The results are expressed as the ratio of pledget activity over the average plasma activity (See worksheet)
- Normal pledget to plasma radioactivity ratios do not exceed 1.3

- When imaging CSF leaks, obtain ANT, POST, RLAT and LLat images.
- Position patient in the position that maximizes the leak
- An anterior picture of the abdomen may be taken to look for swallowed radioactive CSF in the intestines
- Cisternography may be used to assess the patency of a lumboperitoneal shunts.
- Acquire serial 1-minute digital images of the abdomen in the RLAT projection for the first 20 minutes after injection
- At 2 hours, acquire ANT and RLAT images of the abdomen
- At 4 and 24 hours, acquire ANT and RLAT images of the abdomen and head

Gastric Emptying

Isotope:
99mTc Sulfur Colloid

Adult Dose:
2.0 mCi

Indications:
- Diagnosis of functional gastric dysmotility.
- Used orally for esophageal transit studies: Gastroesophageal reflux
- Scintigraphy, and for the detection of Pulmonary aspiration of gastric contents. Emptying rate of a solid phase radio-labeled test meal provides a quantitative means to assess gastric function: Suspected gastric stasis (patients whose symptoms suggest gastric stasis), Post vagomy, Diabetes mellitus, Scleroderma, Intestinal pseudo-obstruction.

Patient Prep:
- Overnight fast or nothing to eat or drink for 6-8 hours prior.
- Patient must be off Reglan (Metaclopramide) Zantac, Prevacid, and Phenergan
- Patient should be done in the morning because the gastric emptying time varies with the time of the day.

Exam Time:
- Four hours

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window

Temperature danger zone lies within the range of 40 to 140 degrees. This is prime temperature for bacteria to grow and cause food to be unsafe to consume. Eggs must be cooked to 160 degrees to be at safe serving temperature.

If you know there has been a delay in serving eggs from the time you got them from our kitchen then I would suggest putting them in the microwave for about 15 seconds to bring them back up to temp and then use the digital thermometer to ensure they are at the safe reheat temp of 165. After reheating the eggs inject the 500uCi Tc99mSC.

Eggs have approximately a hold time of 2 hours before they would need to be discarded.

Protocol:
- Egg beaters mixed with the 99mTc Sulfur Colloid should be cooked in the microwave until done. Served with toast and strawberry jelly and a cup of water. Patient should eat the meal in under 10 minutes.
- One-minute images in the anterior and posterior position will be acquired immediately after the meal and at the 1, 2 and 4-hour mark.

Processing:
- Draw regions of interest around the stomach and fill in the counts on the appropriate worksheet which can be found at the end of this manual.

Gastric Emptying Liquid

Isotope:
- 99mTc Sulfur Colloid

Adult Dose:
- 2 mCi

Indication:
- To determine presence or absence of gastroesophageal reflux and/or pulmonary aspiration.

Patient Prep:
- Overnight fast or nothing to eat or drink for 6-8 hours prior.
- Patient must be off Reglan (Metaclopramide) Zantac, Prevacid, and Phenergan
- Patient should be done in the morning because the gastric emptying time varies with the time of the day.

Exam Time:
- 1 hour

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window

Protocol:
- 2mCi 99mTc Sulfur Colloid is mixed with 8 oz. of Orange Juice
- Images acquired using a 60 min Dynamic image

Processing:
- Reframe images to 12 images
- Load reframed Images into Hida Flow and re-label Reflux
- Load dynamic images to Esophageal Motility Analysis

Gastrointestinal Bleeding Study

Isotope:
- 99mTc Ultra tag RBC's

Adult Dose:
- 35 mCi

Indications:
- Detects the extravasation of radiolabeled red blood cells from the vascular space into the gastrointestinal lumen.
- Localization of gastrointestinal bleeding sites and non-gastrointestinal bleeding sites.

Patient Prep:
- None

Exam Time:
- Variable depends on whether and when the bleeding site is identified.
- The study may be terminated as soon as the bleeding site is identified.
- If there isn't a bleed at the end of 2 hours, the study may be terminated.

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window

Protocol:
- ULTRATAG PREPARATION
    - Draw 1-3cc of patients blood (Have approx. 0.15 ml of heparin per ml of blood in syringe you are to draw blood with-if using a bottle of heparin that states 100 units/ml)
    - Transfer blood to reaction vial (Using 19 or 21g needle). Gently mix, wait 5 minutes.
    - Add syringe 1 to reaction vial (syringes are labeled), Gently mix
    - Add syringe II to reaction vial, Gently mix
    - Add TCO4- Pertechnetate to reaction vial, Gently mix, Shield, Wait 20 minutes with periodic mixing. (Should be injected within 30 minutes of preparation.)
    - Mix gently, then draw out blood from the reaction vial and inject. (Use 19 or 21G needle to draw out).
        - Image the flow of injection and static images every 10 minutes in the anterior position for 2 hours or until bleed in identified.
        - Send images to nuclear medicine physician periodically.

Processing:
- Label all images appropriately

Optional Maneuvers:
- Image in other projections may be acquired in needed.

Hepatobiliary Study

Isotope:

- 99mTc Choletec (Mebrofenin)

Adult Dose:

- 5 mCi

Indications:

- The hepatobiliary study successively demonstrates hepatic perfusion, hepatocyte clearance, hepatic parenchymal transit, and biliary excretion as the radiopharmaceutical moves from the injection site to the intestines.
- Diagnosis of acute cholecystitis
- Evaluation of extrahepatic biliary tract obstruction
- Evaluation of the post-surgical biliary tract
- Detection of bile leaks
- Diagnosis of biliary atresia and other congenital anomalies of the biliary tract
- Evaluation of liver transplants

Patient Prep:

- If evaluation of the gallbladder is desired, the patient should have fasted between 6 and 14 hours. (If the patient has fasted for less than 6 hours, delay the study. If the patient has fasted for more than 14 hours give 0.02 mcg/kg of Kinevac intravenously in a 30-minute infusion. Wait at least 20 minutes before beginning the study.)
- The patient must be off pain meds for at least 4 hours prior to this test. Any opiate/Class II Narcotic is included in this screening. These include:

    - Morphine (4hrs) – Extended Relief Morphine must wait 16hrs before doing a HIDA scan.
    - Demerol (6hrs) *Pharmacist reviewed 8/3/2012
    - Oxycontin (4hrs)
    - Fentanyl (4hrs) – Duragesic is a brand name for a pain patch containing Fentanyl. These last for 3 days per the Pharmacist. You must wait 16hrs once the patch is removed before doing a HIDA scan.
    - Loritab (4hrs) PO Med
    - Dilaudid (6hrs)
    - IV Lipids/ TPN do not interfere with this study.
    - Tube Feedings DO interfere and must be DC'ed for 4hrs pre-scan.

    These drugs will restrict the Sphincter of Oddi, preventing Bile from being released into the small bowel.

Exam Time:

- Routine Exam: 60 minutes
- Biliary leak: 90 minutes or until leak is identified.
- Hepatobiliary Scan with ejection fraction: 105 minutes.

Equipment and Energy:

- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window

Protocol:

- Begin imaging immediately after injection of radiopharmaceutical in the Anterior/LAO projection.
- Acquire ANT/LAO images every 10 minutes for 30 minutes, and then acquire a Right Lateral image at 45 minutes. Continue 10-minute images up to 60 minutes.
- OR

- Dynamic imaging for 60 minutes (60 seconds/frame for 60 frames) followed by a 700 kcts Right Lateral Static.
- Check with the Nuclear Medicine Physician to see if delayed images are needed.
- If the gallbladder has not been visualized by 60 minutes, morphine may be given to hasten visualization of the gallbladder if the cystic duct is not obstructed (respiratory depression without a ventilator is a contraindication of morphine).
- Give 2 mg Morphine IV over 2 minutes. Continue imaging for 30 minutes. Take ANT images every 10 minutes beginning immediately after administration of morphine.
- Outpatients cannot drive after administration of morphine, they will need a driver.
- If the gallbladder has visualized, proceed with Kinevac for calculation of the ejection fraction. CCK Dynamic is 60 seconds a frame for 30 frames.
- Infuse 0.02 mcg/kg (Maximum dose of 2.0 mcg) kinevac over 30 minutes. Dilute the calculated dose of kinevac in a 100ml bag of saline. Infuse with IV pump for the 30-minute dynamic CCK ejection fraction protocol.

Processing:

- Reframe the dynamic images by 5 with an output of 12 images. Load into Hida Flow template and snapshot.
- Snapshot Right lateral with correct annotation.
- Follow workflow acquisition for processing of gallbladder ejection fraction. I.e. Draw region of interest around gallbladder and draw a small triangle in the liver for background counts.

  In case of a Kinevac shortage, we will use Boost as a physiological agent to contract the gallbladder***

NM Discovery:

- Contraindications: Patient who is NPO for surgery reasons, Patients who are at risk for aspiration, and patients who cannot take liquids by mouth.

Prep:

- If patient has been NPO for greater than 24 hours, have patient drink a boost, wait 4 hours and start HIDA.

- After the 1-hour hepatobiliary imaging - take the following images 60 second images:
  - Pre-Boost
  - Immediately post Boost
  - 10 minutes post Boost
  - 20 minutes post boost
  - 30 minutes post boost
  - 45 minutes post boost

  Load images into GBEF workflow and process.

Hepatic Hemangioma Study

Isotope:
99mTc Ultra tag RBC's

Adult Dose:
25 mCi

Indications:
- Diagnosis of hepatic hemanigiomas – this study depicts the amount of perfusion (early images) and vascular space (delayed images) within the hepatic lesions. Hemangiomas are distinguished by their relatively decreased perfusion and increased vascular volume compared to hepatic parenchyma and most other hepatic lesions.

Patient Prep:
- None

Exam Time:
- 1 hour

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window
- SPECT software

Protocol:
- Position patient supine with the upper abdomen in the field of view (include entire liver).
- Image the flow of injection and acquire ANT and POST static images depending on the location of the lesion.
- SPECT imaging at 60 minutes following injection of the radiopharmaceutical.
- SPECT parameters: 360 degrees of rotation, 64 total images, 20 seconds per image.

Processing:
- SPECT image reconstruction: snapshot the transverse, sagittal and coronal images for radiologist to review.

Liver Spleen Imaging

Isotope:
99mTc Sulfur Colloid

Adult Dose:
5 mCi

Indications:
- Determining the shape of the liver and spleen as well as detecting functional abnormalities of the reticuloendothelial cells of these organs.

Patient Prep:
- None

Exam Time:
- 1 hour

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window
- SPECT software

Protocol:
- Position patient supine with the upper abdomen in the field of view (include entire liver).
- Image the flow of injection
- Acquire ANT, POST, RAO, LPO, RT LAT, LT LAT, RPO, LAO and ANT Marker static images 15 minutes after initial injection. (1000 kcts per image)
- Use 5 cm marker over liver to measure size and costal margin marker.
- SPECT imaging may be performed if Radiologist recommends.
- SPECT parameters: 360 degrees of rotation, 64 total images, 20 seconds per image.

Processing:
- Label images appropriately.
- SPECT image reconstruction: snapshot the transverse, sagittal and coronal images for radiologist to review.

Lung Ventilation and Perfusion

Isotope:
133Xenon Gas for ventilation
99mTc MAA for perfusion

Adult Dose:
6-40 mCi Xenon
5 mCi MAA

Indications:
- Functional imaging of the lungs.
- Diagnosis of pulmonary embolism; emboli are indicated in the presence of a negative (normal) ventilation scan and a positive (abnormal) perfusion scan.

Patient Prep:
- None

Exam Time:
Ventilation – 6 minutes
Perfusion – 15 minutes

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window
- Gas dispenser with return trap and 3-way valve

Protocol:
- Position patient supine with the lungs within the field of view.
- Acquire a single breath (ventilation) analog image:

1. Instruct the patient to take a deep breath as the 133 Xenon bolus in injected into the delivery system and then hold the breath for as long as possible.
2. Start the dynamic acquisition when the patient's lungs are visualized on the P-scope.
3. After 60 second equilibrate the concentration of 133 Xenon gas within the patient's lungs. Have the patient breath normally for 30 seconds.
4. Acquire washout analog images by turning the valve to washout so that the patient breathes room air in and exhales the Xenon gas into the system trap.
5. Close the Xenon delivery system and remove the mask from the patients face.

*If the patient did not get a good 1st breath and equilibrium, repeat the ventilation acquisition outlined above without moving the patient. *

- Proceed with the Perfusion portion of the exam.
- Inject patient with 99mTc MAA via IV and acquire 500K images in the ANT and POST, RAO and LPO, RT LAT and LT LAT, and LAO and RPO projections.

Processing:
- Snapshot all images in the workflow for the radiologist to view.

Optional Maneuvers:
- Unilateral or regional pulmonary function may be quantitated.

Shunt Study (for Dr. Mueller):

- Acquire ventilation images
- Set camera for Whole Body acquisition

-Immediately after injection of MAA start whole body protocol

- After whole body imaging acquire the perfusion images of the lung
- Snapshot lung images on templates
- Draw regions around anterior whole body and posterior whole body to get total counts
- Draw rectangular region around lungs on anterior and posterior images to get total lung counts

Perform the following calculations to get the shunt percentage:

$$\frac{\text{Sum Whole body counts} - \text{total lung counts}}{\text{Total whole-body counts}}$$

Multiply that number by 100 to get percentage.

- Greater than 15% indicated shunting

Calculation of Lung Shunt Fraction					
Patient Name:				Date:	
MRN:			IR MD		
	Data:	Anterior Liver ROI counts:			
	Liver				
		Anterior Liver Background counts:			
		Posterior Liver ROI counts:			
		Post Liver Background counts:			
	Data:	Right Anterior Lung counts:			
	Lung				
		Left Anterior Lung counts:			
		Ant Lung Background counts:			
		Right Posterior Lung counts:			
		Left Posterior Lung counts:			
		Post Lung Background counts:			
	Net Liver Counts:		#NUM!		
	Net Lung Counts:		#NUM!		
	Shunt fraction:		#NUM!		
	Shunt %:		#NUM!		

Lymphoscintigraphy

Isoptope:
99mTc Filtered Sulfur Colloid

Adult Dose:
1.0 mCi Filtered if injecting the same day of surgery
4-5 mCi FILTERED if injecting the day before surgery

Indications:
- Identification and localization of draining lymph node groups and sentinel nodes in melanoma and breast cancer.
- Lymphedema

Patient Prep:
- None

Exam Time:
- For breast cancer with no imaging – 15 minutes.
- For Melanoma – 120 minutes.
- For Lymphedema – 75 minutes.

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window

Protocol:
- Clean area with Chlora-prep
- Radiologist, Radiologist Assistant, Nuclear Medicine will make 4 intradermal injections in the clockwise fashion around the lesion.
- Begin imaging immediately after injection, taking images ANT and Oblique of lesion until tracer has migrated to lymph nodes.
- Acquire transmission image with Cobalt 57 flood source under patient.

Processing:
- Snapshot images and send to PACS for review.
- Requesting physician may want films to take to surgery.

Optional Maneuvers:
- Bilateral Breast Injections order 2.5mCi in 1.2ml. Split dose into 8 syringes, 4 for each breast with a total of 1.0mCi for each breast.
- For lymphedema order 1.25 mCi of 99mTc Filtered Sulfur Colloid
- For lymphedema, inject 500 uCi 99mTc Filtered Sulfur Colloid into each foot (250 uCi between each webbing of toes) the web spaces of each foot between the great toe and the 2nd toe and between the 2nd and 3rd toe. So, a total of 1 mCi is used for this procedure.
- There will be a total of 4 injections.
- Have patient walk around for 30-60 minutes, return and image Whole body with a scan speed of 8cm/min.
- Snapshot and send to Radiologist

Meckel's Diverticulum Study

Isotope:
99mTc Pertechnetate

Adult Dose:
10 mCi

Indications:
- Detection and localization of a Meckel's diverticulum containing functioning gastric mucosa and other pathologic structures containing gastric mucosa.

Patient Prep:
- None

Exam Time:
- 75 minutes

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window

Protocol:
- Acquire images in the ANT projection for 60 minutes with dynamic acquisition.
- If unable to use dynamic acquisition, statics may be taken every 10 minutes until the one-hour mark.

Processing:
- Snapshot images and send to PACS for review.

Octreotide Study

Isotope:
111Indium Pentetreotide

Adult Dose:
6 mCi

Indications:
- Scintigraphic localization of primary and metastatic neuroendocrine tumors bearing somatostatin receptors. Included are carcinoid, islet cell carcinoma, gastrinoma, insulinoma, VIPoma, motilinoma, medullary thyroid carcinoma, neuroblastoma, paraganglioma, pheochromocytoma, pituitary adenoma, meningioma, small cell lung carcinoma, and undifferentiated APUDoma.

Patient Prep:
- To better visualize the abdomen, patient should be instructed to start a clear liquid diet the day of injection and continue until imaging is completed at 24 hours. The use of laxatives should be considered, especially when the abdomen is the area of interest. The need for bowel prep should be assessed on an individual basis and laxatives should not be used in patients with active diarrhea. Bowel prep may consist of Magnesium citrate or ducolax. Consult NM physician.
- Precautions:
- Insulinoma patients: Octreoscan may produce severe hypoglycemia in patients with insulinoma. An IV solution containing glucose should be administered just before and during Octreoscan administration.
- Concurrent Octreotide0 Therapy: Sensitivity of Octreoscan imaging is reduced in patients receiving therapeutic doses of Octreotide acetate. **Octreotide therapy must be discontinued 72 hours before administration.**

Exam Time:
- Injection- 30 minutes
- 24 HR images: 90 minutes – 120 minutes
- 48 HR images: 90 minutes – 120 minutes*
- 72 HR images: 90 minutes – 120 minutes*

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Medium Energy Collimator
- Energy: 171 and 245 keV with a 20% window

Protocol:
- Acquire static images of the head/neck, chest, abdomen and pelvis in the ANT and POST projection for 10 - 15 minutes.
- SPECT the abdomen to include the liver during the 24 HR images. 128 x 128 matrix with at least 40 sec/stop.

Processing:
- Snapshot images and send to PACS for review.

*Check images with Nuclear Medicine Physician to see if 48- and 72-hour images are necessary.

Parathyroid Study

Isotope:
99mTc Sestamibi

Adult Dose:
25 mCi

Indications:
- Detects and localizes parathyroid adenomas.

Patient Prep:
- None

Exam Time:
- Initially 15 minutes
- Delayed imaging at 3 hours: 45 minutes

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window

Protocol:
- Position patient supine with head and neck extended under detector
- Image the flow of the isotope in the ANT projection
- Take ANT images immediately after flow and at the 10-minute mark
- Patient will return 3 hours later, and 10-minute images will be taken in the ANT, ANT with Sternal notch marked, LAO, and RAO projection.
- SPECT may be performed if advised by Nuclear Radiologist.

Processing:
- Label images and send to PACS for review.

Renal Study- Tubular Secretion

Isotope:
99mTc MAG 3

Adult Dose:
10 mCi

Indications:
- Evaluation of renal perfusion and function
- Evaluation of renal trauma
- Diagnosis of renovascular hypertension
- Detection and evaluation of renal collecting system obstruction and renal transplants

Patient Prep:
- Patient should be well hydrated and should void before the exam.

Exam Time:
- 45 minutes

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window

Protocol:
- Position patient supine with pelvis in the bottom field of view and xiphoid process in the top field of view
- Position the camera under the table for POST images
- Image the initial flow of the tracer to the kidneys
- If indicated give 40 mg Lasix (*unless Patient has previous images with 20 mg Lasix*) during frame 20 of the dynamic acquisition
- Have patient void immediately after exam to reduce gonadal radiation dose

Processing:
- Draw regions of interest around each kidney with backgrounds.
- Enter the time Lasix was given.
- Check graphs and data for accuracy
- Snapshot and send images to PACS for review

Optional Maneuvers:
- For transplant kidney, image in the ANT projection
- For Enalaprilat See worksheet

Thyrogen-Stimulated I-123 Whole Body Scan
See Thyrogen Flowsheet

Isotope:
Sodium Iodine I-123

Adult Dose: Order from ROI
3 mCi I-123 oral capsule
100 uCi standard

Indications:
- Evaluates functional thyroid tissue following thyroidectomy for thyroid cancer
- I-131 ablation in patients unable to tolerate thyroid hormone withdrawal

Patient Prep:
- 3-day exam
- Patient can stay on thyroid medications throughout entire study

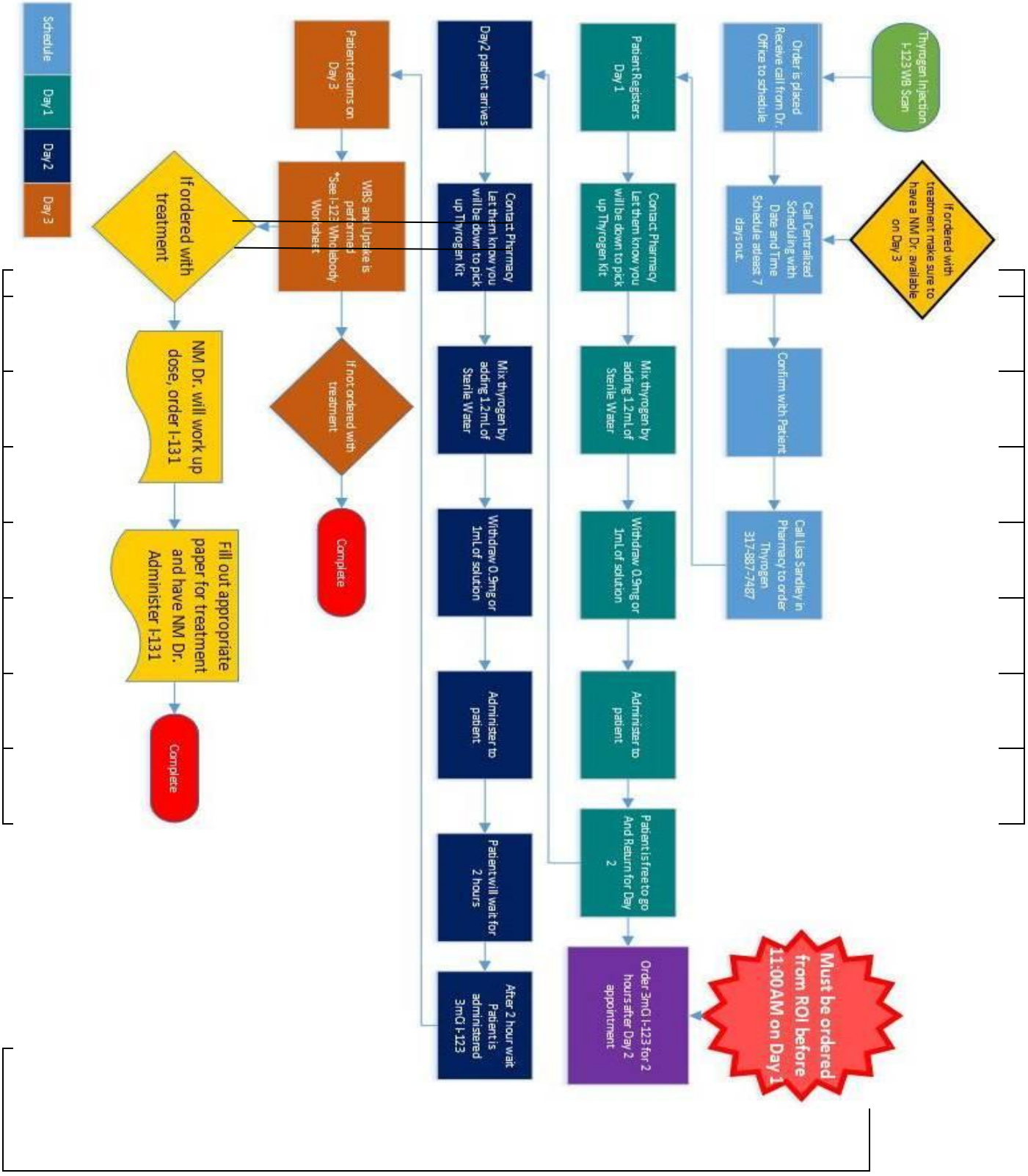
Exam Time:
- Day 1- 15-20 minutes
- Day 2- 10-15 minutes
- Day 2- 15 minutes
- Day 3- 60 minutes

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Collimator: LEHR
- Energy: 159 keV with a 20% window

Protocol:
- Day 1 -Thyrogen injection #1 and blood draw (TSH and Beta HCG)
- Day 2 -Thyrogen injection #2
- Day 2 - 2 hours after Thyrogen I-123 3 mCi oral capsule
- Day 3 -24-hour whole body I-123 scan and uptake
- Uptake use manual mode on Uptake Probe, Count Standard 3 x 1 minute, Count Background 1 x 1 minute, Count Patient Thyroid 3 x 1 minute, Patient Background 1 x 1 minute, be sure to print counts after each 1 min count. Fill out I-123 Whole-body worksheet and calculate uptake.

Processing:
- Process as a Thyroid WBS
- Label accordingly
- If desired take an extra picture of neck area with markers on the chin, suprasternal notch, and xiphoid process
- Snapshot all images and record patient's thyroid uptake on images, send to PACS for review.

Thyrogen Flowsheet
***Posted with color in Department**



Thyroid Therapy/Ablation

Isotope:
I-131 Sodium Iodine

Dose:
Calculated by Nuclear Medicine Physician after Patient has had an Uptake and Scan.

Indications:
Treatment of benign or malignant conditions of the thyroid gland.
- Hyperthyroidism
- Nontoxic multinodular goiter
- Thyroid Cancer

Patient Prep: (Written Directive, Consent, and Instruction are in File Cabinet)
- Patient must discontinue Thyroid Medication. Unless Patient received Thyrogen Injections.
- Low Iodine diet if requested
- TSH, T3, T4, Labs drawn, and results printed
- Previous recent Uptake and Scan
- Beta HCG (Pregnancy Test) drawn and results printed
- Under the Age of 60

Exam Time:
30 Minutes

Equipment:
Dose Calibrator

Protocol:
- Labs, Uptake, Scan, and Written Directive given to Nuclear Medicine Physician to prescribe a dose. (Dose must be written on written directive and signed and dated by prescribing Nuclear Medicine Physician)
- Order prescribed Dose
- 2 Technologist must Check Name, DOB, Driver's License, both Technologist must Initial Written Directive
- Nuclear Medicine Physician explains therapy/ablation to patient and gives patient restrictions
- Patient Signs Consent
- Nuclear Medicine Physician verifies dose in dose calibrator, records administering dose, signs and dates Written Directive.
- Dose is Administered
- Instruct Patient not to eat anything for 1 hour

Processing:
- Place dose sticker on Control Sheet
- Make copy of Control Sheet, Consent, Written Directive; have copy scanned into PACS
- Originals placed in Folder and put in file Cabinet

Thyroid Imaging Study

Isotope:
123I Sodium Iodide

Adult Dose:
200-400 uCi

Indications:
- The thyroid imaging study with radioiodine demonstrates the distribution of functioning thyroid tissue, including ectopic tissue, since thyroid tissue is the only tissue that concentrates large amount of iodine.
- Evaluation of palpable nodules, abnormal thyroid gland, ectopic thyroid tissue, and congenital hypothyroidism.

Patient Prep:
- Patient must be off thyroid medications for 4-6 weeks (see list)
- No intravenous or intrathecal iodinated contrast material for at least 6 weeks.
- Copy of labs from physician office to include with images for Radiologist

Exam Time:
- Initially: Dose administration is 10 minutes
- 24-hour delay imaging: 45 minutes

Equipment and Energy:
- Gamma camera: Dual head, Large field of view
- Energy: 140 keV with a 20% window

Protocol:
- Day 1: Count the capsule on the uptake probe and take a 1-minute static image on the camera under the thyroid acquisition.
- Make sure patient is prepped, follow Red Rule, and give patient the thyroid capsule.
- Day 2: Position patient supine under the detector, take 10-minute ANT, ANT with markers, LAO and RAO images. Also measure the patient's thyroid and background with the uptake probe.

Processing:
- Snapshot all images and record patient's thyroid uptake on images, send to PACS for review.

Xofigo

Isotope:
Radium 223

Dose:
Calculated by Xofigo Pharmacy based on weight

Indications:
Castration Resistant Prostate Cancer with symptomatic bone metastases

Patient Prep:
None

Exam Time:
30 Minutes

Equipment:
- Dose Calibrator
- Personal Protective Equipment

Protocol:
- Radiation Oncology will call with date and time to schedule
- Radiation Oncology will order dose, once dose is ordered have Radiation Oncology fax over Written Directive with Radiation Oncologists Signature and date
- Once dose is received and checked in, measure dose and insert information of initial assay into the Xofigo Excel Worksheet on Computer. (Initial Assay Upon Receipt)
- Radiation Oncology Nurse will obtain IV and Vitals
- Radiation Oncologist should where PPE equipment (Gown and Shoe covers)
- Radiation Oncologist will administer dose over 1 minute, using a three way stop cock flush the syringe and IV with 30mL of Normal Saline
- Measure Syringe for residual, insert information from assay into the Xofigo Excel Worksheet (Calculation Post Injection)
- Using information from Xofigo Excel Worksheet fill out remainder of the Written directive.
- Survey Patient 10 cm from umbilicus and Room, record on Written Directive
- Obtain Radiation Oncologist Signature on completed Written Directive
- Make 2 copies of Written Directive for Radiation Oncology Nurse and to be scanned into PACS
- Place Original in folder and file in File Cabinet under Xofigo

Y-90 SirTex

Isotope:
Tc99m -4mCi
Yttrium 90 -81mCi

Dose:
Calculated by RSO and Administering MD

Indications:
Treatment of unresectable metastatic liver tumors from primary colorectal cancer with adjuvant intra-hepatic artery chemotherapy

Patient Prep:
Given by IR nurse

Exam Time:
IR: 1-2 hours
NM: 30 mins

Equipment:
-Dose Calibrator
-Gamma Camera
-Acrylic Shield
- SirTex Binder

Protocol:
-IR Nurse will schedule mapping and procedure; they will email RSO to conform date
- Once date is confirmed and orders are entered, schedule on NM work list

Mapping/Shunt
-Mapping order 4mCi Tc99m
-IR Doctor will call with how to split
- IR will call when ready for Dose
-take dose and bag to IR for waste
-IR will call when finished to come pick up waste
-Short Stay will call for time to bring patient over for imaging

- Imaging performed –Collimators LEHR
-Ant/Post Lungs -5 min
-Ant/Post Liver - 5 min
-Tomo- 20 sec/frame

- **Image Processing**
  - -Draw ROI of lungs/liver and background
  - - fill out the Excel Y-90 Shunt Calculation worksheet
  - -Print and Scan into Pacs

Treatment
-Refer to Sir-Spheres Y-90 order form for date order is due by.
-Fill out order form and email to csusa@sirtex.com , ask for confirmation
-SirTex Rep and RSO will be present for the drawing of the dose
-After administration short stay will call for time for images
-Images performed- Collimators MELP

-Ant/Post Lungs- 5 min
-Ant/Post Liver- 5 min
- Tomo- 20 sec/frame
-Enter administered Dose in Epic Comments
-Review and send to Pacs