



## Nuclear Medicine Protocols

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## Bone Scan

### Isotope:

<sup>99m</sup>Tc Medronate (MDP)

### Adult Dose:

30 mCi

### Indications:

<sup>99m</sup>Tc 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 should be obtained if 3 phase bone scan is ordered.

### Patient Prep:

- Drink fluids during the 3-hour waiting period.

### Exam Time:

- Initial injections: 15 min (Flow if necessary, for 2 minutes, followed by immediate blood pool static image.)
- 3 hour delayed imaging

### Equipment and Energy:

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

### Protocol:

- Have patient empty bladder immediately prior to imaging
- Have patient empty all pockets and remove any belt, suspenders, necklace, and metal objects
- Image supine
- Table motion of 10-15 cm/min
- Acquire additional statics as needed. If performing a 3 phase for knee or hip replacement acquire lateral image.

### Processing:

- Annotation for image identification, label as necessary, tech initials

## **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:

- Will be part of the patients 2-day bone indium exam

### 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 of the area in question

### Processing:

- Annotation for image identification, label as necessary, w/tech initials

Note - When doing bone marrow scan in conjunction with bone indium, draw 60cc's of patient's blood first to send to the radiopharmacy to be labeled. Minimum amount to perform exam is 40cc.

Indication/Diagnosis	Appropriate Scan to Order
1. Stress Fracture	1. Three Phase Bone Scan
2. Prosthesis Loosening with <u>NO</u> mention of infection	2. Three Phase Bone Scan
3. Reflex Sympathetic Dystrophy	3. Three Phase Bone Scan
4. Osteomyelitis/Infection a) <u>NO</u> prosthesis or hardware b) <u>NO</u> recent surgery or debridement at site of possible infection	4. Three Phase Bone/ <sup>111</sup> IN Scan - 2-day exam with 3 patient visits
5. Osteomyelitis/Infection a.) <u>WITH</u> prosthesis or hardware b) Recent surgery or debridement at site of possible infection	5. Three Phase Bone/ <sup>111</sup> IN Scan <u>WITH</u> Bone Marrow Scan 2-day exam with 4 patient visits
6. Osteomyelitis/Infection vs. LOOSENING a.) <u>WITH</u> prosthesis or hardware b) Recent surgery or debridement at site of possible infection	6. Three Phase Bone/ <sup>111</sup> IN Scan <u>WITH</u> Bone Marrow Scan 2-day exam with 4 patient visits
7. Charcot Joint	7. Three Phase Bone/ <sup>111</sup> IN Scan <u>WITH</u> 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

## Bone Indium Scan

### Isotope:

Indium-111 labeled White Blood Cells - tagged by radio pharmacy  
Tc99mMDP

### Adult Dose:

500 uCi In111WBC  
30mCi Tc99mMDP

### Indications:

- Osteomyelitis
- Infection
- Loosening of prosthetic joint

(See attached list for variation on bone imaging)

### Patient Prep:

- None

### Exam Time:

- Day one:
  - 1<sup>st</sup> visit Draw 60cc of patient's blood to send to pharmacy. 40cc minimum
  - 2<sup>nd</sup> visit re-inject patients' blood that is tagged with Indium-111 and perform bone flow
- Day two
  - 1 visit to perform whole-body and static images

### 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:

- Whole-body and statics of area of concern

### Processing:

- Display Tc99m and IN111 pictures side by side and label them appropriately. Include tech initials

## Bone SPECT

### Isotope:

Tc99mMDP

### Adult Dose:

30mCi

### Indications:

- PARS defect
- Spondylolysis
- To evaluate fractures due to bone trauma

(See attached list for variation on bone imaging)

### Patient Prep:

- Drink fluids during the 3-hour waiting period

### Exam Time:

- 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
- 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: clockwise
- Patients arms raised above their head

### Processing:

- SPECT- Reconstruct transverse, sagittal and coronal images
- Label with tech initials

## Brain Survival

### Isotope:

Tc99mCeretek

### Adult Dose:

30 mCi

### Indications:

- Brain Death

### Patient Prep

- IV access must be obtained before starting the procedure

### Exam Time:

30 minutes

### Equipment and Energy:

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

### Protocol:

- Flow taken to establish blood flow to the brain.
- Position patient supine ensuring the entire head is within the field of view.
- Anterior and either lateral image taken at 15 mins post injection

### Processing:

- Label all images appropriately and tech initials

## Cisternography (CHS Only)

### 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 extravasation, the study is to be terminated.

### Processing:

- Label images appropriately including tech initials

### Optional Maneuvers:

- Quantitative diagnosis of CSF rhinorrhea:
- 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:

Tc99m Sulfur Colloid

### Adult Dose:

2mCi

### Indications:

- Diagnosis of functional gastric dysmotility.
- Post-operative changes
- Drug effects

### Patient Prep:

- Overnight fast or nothing to eat or drink for 4 hours prior.
- Patient must be off Reglan (Metaclopramide) Zantac, Prevacid, Tums, Phenergan and any other gastric motility meds for 72 hours prior to the exam
- No pain narcotics/pain patches for 48 hours prior to exam
- No laxatives for 24 hours prior to exam

### 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 165 degrees to be at safe serving temperature.**

### Protocol:

- 120 mL (~4 oz) liquid egg whites mixed with 2mCi of 99mTc Sulfur Colloid should be cooked in the microwave until done. Served with 2 piece of white toast and 30g jelly and 120ml (4oz) 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.
- \*\* If patient has egg allergy, please consult with Radiologist for alternative i.e. Ensure Plus.

### 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.
- Enter counts into excel program to get accurate percentage, print page, scan to PACS

## **Gastroesophageal Reflux and/or Pulmonary Aspiration**

### Isotope:

- Tc99m 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 4 hours prior.
- Patient must be off Reglan (Metaclopramide) Zantac, Prevacid, and Phenergan 72 hours prior to exam
- No narcotics 48 hours prior to exam
- No laxatives 24 hours prior to exam
- 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
- 60 min Dynamic image is performed.

### Processing:

- Label images and tech initials

## Gastrointestinal Bleeding Study

### Isotope:

- Tc99m Ultra tag RBC's

### Adult Dose:

- 30 mCi

### Indications:

- GI bleeding

### Patient Prep:

- None

### Exam Time:

- 2 hours (30 mins to draw and label blood, and 90 mins of imaging)
- If the bleeding site is identified early on, then the exam can be completed at 45mins-60mins

### 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 I to reaction vial (syringes are labeled), Gently mix
  - Add syringe II to reaction vial, gently mix
  - Add TCO4- Perchnetate 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 patient supine with the inferior margin of the liver at the top of the field of view.
- Reinject the patient's blood and begin imaging the flow. Perform a 90 min dynamic study. Pt is complete after 90 mins. No delays will be taken. As said above, if the bleed is identified the exam may be ended early.

### Processing:

- Label all images appropriately including tech initials

### Optional Maneuvers:

- A rt lateral at the end of the exam may be beneficial

## Hepatobiliary Study

### Isotope:

- Tc99m 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

### Patient Prep:

- If evaluation of the gallbladder is desired, the patient should have fasted 4 hours. If the patient has fasted for more than 24 hours give 0.02 mcg/kg of Kinevac intravenously over 3-5min diluted in 10ml saline and begin exam.
- 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: 60 minutes
- Hepatobiliary Scan with ejection fraction: 120 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 position.
- Acquire the following images: ANT imm, 5,10, 15, 20, and 30 min, RTLAT 45 min, and LAO 60 min
- OR
- Dynamic imaging for 60 minutes (60 seconds/frame for 60 frames)

- **If Outpatient** and there is no GB visualized at 1 hour and they have no immediate symptoms the patient may leave and scan the appropriate paper into PACS
- **If Inpatient** and the gallbladder has not been visualized by 60 minutes morphine may be given to rule out acute cholecystitis
- MORPHINE: Give 0.04mg/kg not exceeding 4mg diluted in 10cc saline slowly over 2 mins. To be given only by a nurse or MD. Image for 30 minutes. Take ANT images every 5 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. (SOUTH ONLY). North and East use 8oz Boost Plus
- SOUTH: 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.
- NORTH AND EAST: take preboost image, have patient drink boost and wait 15mins, take post Boost images at 15, 30, 45 and 60 mins.

Processing:

- CHS Only: Reframe the dynamic images by 5 with an output of 12 images. Load into Hida Flow template and snapshot.
- CHS Only: Snapshot Right lateral with correct annotation.
- ALL: 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.
- Label w tech initials

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

Prep:

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

Load images into GBEF workflow and process.

## Hepatic Hemangioma Study

### Isotope:

Tc99m Ultra tag RBC's

### Adult Dose:

30 mCi

### Indications:

- Diagnosis of hepatic hemangiomas – 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:

- Anterior flow
- Static images in the ANT/POST, RAO, LAO, RPO, LPO, and lateral positions for 800k.
- Anterior marker image with the 10cm marker along the costal margin and the 5cm marker in the liver.
- SPECT imaging if requested by ordering MD.
- 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.
- Label with tech initials

## Liver Spleen Imaging

### Isotope:

Tc99m 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 the 10cm marker along the costal margin.
- SPECT imaging may be performed if Radiologist recommends, or requested by ordering MD.
- SPECT parameters: 360 degrees of rotation, 64 total images, 20 seconds per image.

### Processing:

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

## Lung Ventilation and Perfusion

### Isotope:

<sup>133</sup>Xenon Gas for ventilation or Tc<sup>99m</sup>DTPA aerosol  
Tc<sup>99m</sup> MAA for perfusion

### Adult Dose:

6-40 Ci Xenon or 30mCi DTPA  
5 mCi MAA

### Indications:

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:

40 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
- Aerosol canister, tubing, O<sub>2</sub>

### Protocol:

#### CHS:

- 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 <sup>133</sup>Xenon bolus is 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 <sup>133</sup>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 1<sup>st</sup> breath and equilibrium, repeat the ventilation acquisition outlined above without moving the patient. \*

#### CHN & CHE:

- Hook up O<sub>2</sub> to canister and place mouthpiece in patient's mouth with nose clamp securely in place.
- Turn O<sub>2</sub> up to 15 inject aerosol into tubing and vent patient for a minimum of 5 mins. Instructing them to keep their mouth tight around the mouthpiece.
- After ventilation have the patient lay arms above their head and obtain images in the ant/post, lao, rao, lpo, rpo and lateral positions.

#### ALL:

- 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. Label and include tech initials

Optional Maneuvers:

- Unilateral or regional pulmonary function may be quantitated.

CHS: 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:

Sum Whole body counts – total lung counts

---

Total whole-body counts

Multiply that number by 100 to get percentage.

- Greater than 15% indicated shunting

CHN SHUNT:

- Following injection of 4mCi Tc99mMAA intrahepatic by the IR doc ant/post 10 min images of each the lungs and liver are obtained. Process using the below excel program.

Calculation of Lung Shunt Fraction

Patient Name:		Date:	
MRN:		IR MD	
	Data:	Anterior Liver ROI counts:	<input type="text"/>
	<b>Liver</b>		
		Anterior Liver Background counts:	<input type="text"/>
		Posterior Liver ROI counts:	<input type="text"/>
		Post Liver Background counts:	<input type="text"/>
	Data:	Right Anterior Lung counts:	<input type="text"/>
	<b>Lung</b>		
		Left Anterior Lung counts:	<input type="text"/>
		Ant Lung Background counts:	<input type="text"/>
		Right Posterior Lung counts:	<input type="text"/>
		Left Posterior Lung counts:	<input type="text"/>
		Post Lung Background counts:	<input type="text"/>
	Net Liver Counts:	<input type="text" value="#NUM!"/>	
	Net Lung Counts:	<input type="text" value="#NUM!"/>	
	Shunt fraction:	<input type="text" value="#NUM!"/>	
	Shunt %:	<input type="text" value="#NUM!"/>	

## Lymphoscintigraphy (CHS Protocol)

### Isotope:

99mTc Filtered Sulfur Colloid

### Adult Dose:

- 1.2 mCi filtered sulfur colloid 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 Chloro-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 2<sup>nd</sup> toe and between the 2<sup>nd</sup> and 3<sup>rd</sup> 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:

Tc99m 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.
- Obscure bleeding

### Patient Prep:

- None

### Exam Time:

- 60 minutes

### Equipment and Energy:

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

### Protocol

- Lay the patient supine with the camera over the abdomen. The right side of the patient should be elevated with a small wedge or pillow to keep secretions within the stomach.
- A 2 sec/frame dynamic flow is done for 120 seconds
- An immediate anterior image is taken following the flow. Images at 5, 10, 15, 20, 30, 45, and 60 mins are taken.
- It is possible to do a dynamic study for 60 sec/frame for 60 mins.

### Processing:

- Snapshot images and send to PACS for review, and label with tech initials.

## Octreotide Study

### Isotope:

<sup>111</sup>Indium Pentetreotide

### Adult Dose:

6 mCi

### Indications:

- Scintigraphy 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:

- Bowel prep is required prior to octreoscan. Patient should start a mild over the counter laxative the morning of day 1 and continue throughout the 48 hours of the exam.
- Ample fluid intake is necessary during the period of imaging as a support to renal elimination and the bowel cleansing process.

### 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 Octreotide 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- 15 minutes
- 4 HR images: 30 minutes, whole-body only
- 24 HR images: 1 hour, whole-body and SPECT
- 48 HR images: 1 hour, whole-body and SPECT (most patients are done imaging at this point. Check with Rad)
- 72 HR images: 1 hour, whole-body and SPECT (only performed if requested by Rad)

### Equipment and Energy:

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

### Protocol:

- Whole-body images at 4, 24, and 48 hours
- SPECT the abdomen to include the liver during the 24 and 48 HR images. 128 x 128 matrix with at least 40 sec/stop.

### Processing:

- Snapshot images and send to PACS for review. Include tech initials

## Parathyroid Study

### Isotope:

Tc99m Sestamibi

### Adult Dose:

25 mCi

### Indications:

- Detects and localizes parathyroid adenomas.

### Patient Prep:

- None

### Exam Time:

- Initially 45 mins
- Delayed imaging at 3 hours: 20 minutes

### Equipment and Energy:

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

### Protocol:

- Lie patient supine on table with head at the top of the pillow so the neck is extended
- Inject patient and wait 10 mins.
- Position the patient under the camera so the tip of the heart is at the bottom of the field of view
- Take anterior, lao and rao images at 10 mins post injection.
- After initial static images a SPECT is performed on all patients
- Patient will return 3 hours later to retake the anterior, lao, and rao static images.

### Processing:

- Label images and send to PACS for review. Including tech initials

## Renal Study w/and w/out Lasix

### Isotope:

Tc99m MAG 3

### Adult Dose:

5 mCi

40mg Lasix for adults, 0.5mg/kg for children

### Indications:

- Chronic renal failure, obstruction, hypertension, infection, hematoma, trauma

### Patient Prep:

- Patient should be well hydrated and should void before the exam.
- No Lasix 24 hours prior to the start of the exam
- If the patient has any sort of drain or Foley in place discuss with the Rad to see if it should be clamped shut

### 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
- Set up IV and inject
- A dynamic flow is obtained during injection
- NO LASIX: 60 sec/frame images are taken immediately following the flow for a total of 30 mins.
- LASIX: 60 sec/frame images are taken immediately following the flow for a total of 41 mins.
  - Inject the 40mg Lasix over a 3 min time span at 15 mins injection of MAG3.
  - Try to continue the Lasix images for at least 20 mins post Lasix injection. Have the patient hold it as long as possible.
  - The patient should void when exam ends and obtain a 60 sec post void static image.

\*any patient with a diagnosis on kidney stones will automatically be a renal with Lasix study.

### Processing:

- Draw regions of interest around each kidney with backgrounds.
- Mark the time Lasix was given on the graph
- Check graphs and data for accuracy
- Snapshot and send images to PACS for review. Include tech initials

### Optional Maneuvers:

- For transplant kidney, image in the ANT projection

## Renal Scan w/Vasotec

### Isotope:

Tc99m MAG 3

### Adult Dose:

2 mCi baseline

8 mCi post vaso study

20mg Lasix

0.04mg/Kg of Vasotec not to exceed 2.5mg (diluted in 10cc saline)

### Indications:

- Renal Artery Stenosis, neurovascular hypertension

### Patient Prep:

- Patient needs to be off ALL Ace inhibitors for 48 hours prior
- Patient needs to be off ALL blood pressure meds for 24 hours prior
- Patient needs to be off Lasix for 24 hours prior
- Patient should be very well hydrated
- Patient should empty their bladder immediately prior to exam

### Exam Time:

- 90 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
- Set up IV
- Inject the 2 mCi dose of Mag3 and begin flow
- 60 second images are obtained for 30 mins immediately following the flow
- The patient's blood pressure should be taken at the end of the first set of images. Patients BP needs to be above 140. Inform radiologist if this is not the case.
- Patient should empty bladder and lie back down on the table
- Inject the diluted Vasotec IV at a rate of 0.5mg/minute
- BP's should be taken every 5 minutes for the remainder of the exam and recorded
- 10 minutes post injection of Vasotec position the patient under the camera and begin the second set of images. Inject with the 8mCi dose of Tc99mMAG3.
- At 3 mins into the study 20mg Lasix is injected over a 3 min time span
- The study should run at minimum 20 mins post Lasix injection or until the patient asks to stop due to inability to hold bladder.
- Have the patient void and take a 1-minute post void image

### Processing:

- Draw regions of interest around each kidney with backgrounds.
- Process both the pre and post vasotec scans with the protocol on the camera
- Mark the time Lasix was given on the graph
- Check graphs and data for accuracy
- Snapshot and send images to PACS for review. Include tech initials

## Thyrogen-Stimulated I-123 Whole Body Scan

\*See Thyrogen Flowsheet\*

**\* All thyroid whole-body scans, thyrogen whole body scans, therapies, and ablations MUST be schedule between the Nuc Med dept and the ordering doctors off. All proper paperwork will be filled out and completed by NM staff. NM staff will then call central scheduling with dates and times for the appropriate exams.**

### 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
- Patient must be NPO 4 hours prior to taking the I123 pill on the second day, and NPO 1 hour after.

### Exam Time:

- Day 1- 15-20 minutes
- Day 2- 10-15 minutes
- Day 2- 15 minutes
- Day 3- 60 minutes

### Equipment and Energy:

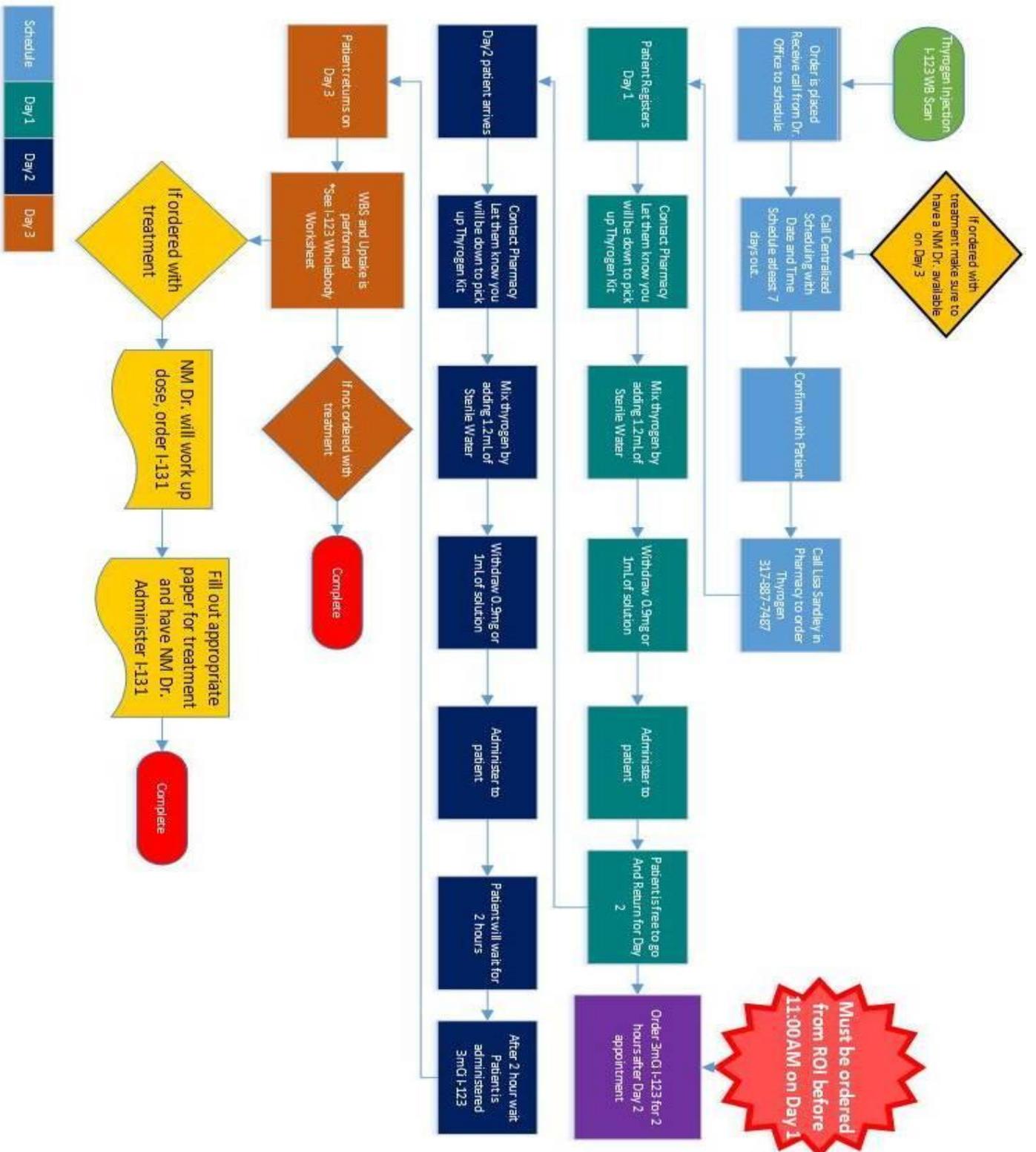
- Gamma camera: Dual head, Large field of view
- Collimator: LEHR
- Energy: 159 keV with a 20% window

### Protocol:

- Day 1 -Thyrogen injection #1 by nursing staff
- Day 2 -Thyrogen injection #2 by nursing staff
- Day 2 - 2 hours after Thyrogen the patient returns to take the 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 anterior or pinhole of the patient's neck
- Snapshot all images and record patient's thyroid uptake on images, send to PACS for review.



Schedule Day 1 Day 2 Day 3

### I-123 WHOLEBODY WORKSHEET

Tech: \_\_\_\_\_

Date: \_\_\_\_\_

		STD CNTS	PT CNTS
PT DOSE uCi			
STD DOSE uCi			
		-/- 3	-/- 3
	<b>TOTAL</b>		
	<b>-BKG</b>		
	<b>TOTAL CNTS</b>		

$$\% \text{ UPTAKE} = \frac{\text{PT CNTS}}{\text{STD CNTS} \times \frac{(\text{PT DOSE})}{\text{STD DOSE}}} \times 100$$

$$\% \text{ UPTAKE} = \frac{\quad}{(\quad) \times (\quad)} \times 100 = \quad \%$$

## Thyroid Therapy (hyperthyroid)/Ablation (thyroid cancer)

**\* All thyroid whole-body scans, thyrogen whole body scans, therapies, and ablations MUST be schedule between the Nuc Med dept and the ordering doctors off. All proper paperwork will be filled out and completed by NM staff. NM staff will then call central scheduling with dates and times for the appropriate exams.**

### Isotope:

I-131 Sodium Iodine

### Dose:

Calculated by Nuclear Medicine Physician after Patient has had an Uptake and Scan or thyroid whole body/thyrogen whole body/thyrogen injections only.

### 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 for 2 weeks prior for ablation (provided by ordering doctor's office)
- TSH, T3, T4, Labs drawn, and results printed
- Previous recent Uptake and Scan/imaging
- Beta HCG (Pregnancy Test) drawn and results printed: Under the Age of 50
- Pathology reports printed and entered in patients file
- Patient must be 6 weeks post thyroidectomy to have an ablation performed
- If no thyrogen is given TSH must be above 30

### 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
- Technologist must perform 2 pt. ID with any of the following: Name, DOB, Driver's License
- Nuclear Medicine Physician explains therapy/ablation to patient and gives patient restrictions
- Patient Signs Consent
- Dose is measured in the dose calibrator
- Patient release calculation is performed PRIOR to dosing patient, printed and entered into file
- Dose is Administered
- Instruct Patient not to eat anything for 1 hour
- ALL patients will return for a 7-day post ablation scan IF for thyroid cancer.

### Processing:

- Scan paperwork into PACS and Originals placed in Folder and put in file Cabinet

## Thyroid Uptake and Scan Study

### Isotope:

I123 Sodium Iodide  
Tc99mO4-

### Adult Dose:

100 uCi I123 pill  
10mCi Tc99mO4- IV

### 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, congenital hypothyroidism, abnormal thyroid lab work, hyperthyroidism, Graves, Thyroid Storm

### Patient Prep:

- Patient must be off Synthroid x 6 weeks, PTU x 3 days, Armour x 2 weeks, Tapazol (methimazole) x 3 days, Cytomel x 2 weeks (see list)
- No intravenous or intrathecal iodinated contrast material for at least 6 weeks.
- Patient needs to be NPO 4 hours prior to the administration of the I123 pill and NPO for 1-hour post administration.

### Exam Time:

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

### Equipment and Energy:

- Gamma camera: Pinhole collimator
- Energy: 140 keV with a 20% window

### Protocol:

- Day 1: Count the capsule in the uptake probe and take a room background. Save to thyroid probe.
- Make sure patient has been off all meds, has had no Contrast, is not pregnant or breast feeding and proceed with dosing the patient.
- Day 2: Begin with 2 uptake counts on the thyroid probe. We do this twice so we can average them out. You want each uptake percent to be within 5% of each other. Record these numbers of requisition.
- Using the Pinhole collimator position the patient's thyroid in the middle of the field of view.
- **Images taken:**
  1. distance with the pinhole away from the patient to include salivary glands and mediastinum
  2. Pull pinhole within 4 fingers width of the patient's neck. Take anterior image.
  3. Marker image w/ 5cm marker on the patient's neck vertically in the middle of the thyroid.
  4. LAO @ 30 degrees
  5. RAO @ 30 degrees
- All images should be taken for 120K.

### Processing:

- Snapshot all images, record patient's thyroid uptake on images, include tech initials, and send to PACS

## 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 wear 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:

Yttrium 90

### 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 and syringe shield
- Venting needles
- Dextrose
- Absorbent paper
- drawing supplies that comes with dose provided by Sirtex

### Protocol:

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

### **Treatment**

- RSO will be present for the drawing of the dose.
- follow drawing guidelines provided by the company insert

### **Images performed**

- Collimators MELP
- Tomo- 20 sec/frame
- around the liver
- set analyzer to Bremstrahlung
- Review and add tech initials, and send to Pacs

## Lymphangiograms (CHN & CHE Breast Surgeons)

### Isotope:

Tc99mSC (unfiltered ordered)

### Adult Dose:

Dependent on the Surgeons preference. See below.

### ***Dr. Goedde, Dr. Nate, Dr. Goulet & Dr. Kim:***

Normal: 1.2mCi Tc99m filtered sulfur colloid in 1.5mL saline. Add 2mL lidocaine with a long 25g needle, if requested by surgeon.

Melanoma style: 1/2mCi Tc99mSC in 0.5mL saline. Divide into 2 syringes w/ 30 g needle.

Bilateral breast injections order one normal dose per breast

\*\*Technologist will inject Dr. Goedde's patients.

Dr. Nate, Dr. Goulet, and Dr. Kim's doses will be delivered to the surgery center for injection in surgery by the surgeon\*\*

### ***Dr. Wagner:***

1.0mCi Tc99mSC in 0.2mL saline divided into 2 syringes w/ a 30g needle. (Extremities/head)

1.0mCi Tc99mSC Filtered in 0.2mL saline divided into 2 syringes w/ a 30g needle (trunk and reinjections)

5.0mCi Tc99mSC in 1.0mL: this dose will be filtered by the tech for any reinjections or trunk injections. Once filtered this will be used for the above 1.0mCi filtered injections.

### ***Lymph edema:***

2.0mCiTc99mSC in 1.0mL saline. Divided into 4 syringes w 30g needle

### 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 – 10 minutes
- For Melanoma – 60-120 minutes.
- For Lymphedema – 75 minutes.

### Equipment and Energy:

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

### Protocol:

- Breast injection using Tc99mSC is injected by the tech into the subcutaneous tissue subareolar in the breast. There is no imaging for any breast injection.

- Melanoma injections are done intradermal around the melanoma site by the technologist. The injections will be spaced evenly at either the 3 and 9 o'clock position or the 12 and 6 o'clock position.
- **Images:** should begin immediately after injection. Images should be done every 5 mins lasting 60 seconds.
  - Back-axilla, groin, and neck
    - Legs-pelvis and posterior knees
    - Arms-axilla, neck, elbow
- If there is no lymph node showing at 30 mins then REINJECT, the patient 1.0mCi Filtered SC.
- Throughout the imaging take transmission films with the cobalt sheet source to outline the body.
- Mark the patient's skin where the sentinel lymph node is on film with surgical marker at the end of the exam
- Lymph edema injections should be placed into two web spaces on either foot. This is done by the technologist.
  - **Images:** should begin immediately after injection with images of the feet, knees and pelvis for 2 mins each. Repeat images at 30 mins and 60 mins post injection.

Processing:

- Snapshot images and send to PACS for review.
- Process lymph edema with the attached worksheet and scan into PACS

## Lymphangiograms (using Lymphoseek®)

### **Isotope and Radiopharmaceutical:**

Tc-99m tilmanocept (Lymphoseek®)

### **Adult Dose Range (breast lymph node mapping):**

0.4 – 1.3 mCi in 0.1 cc

### **Adult Dose Range (melanoma):**

0.5 mCi per injection in 0.1 cc (2 or 4 syringes/injections total, based on physician preference)

**NOTE:** Addition of lidocaine is **NOT** recommended for this drug.

### **Indications:**

- Identification and localization of draining lymph node groups and sentinel nodes in melanoma and breast cancer

### **Patient Prep:**

- None

### **Exam Time:**

- Breast cancer with no imaging- 10 minutes
- Melanoma- 60-120 minutes

### **Equipment and Energy:**

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

### **Protocol- breast injection:**

- Breast injection using Tc-99m tilmanocept is injected by the nuclear medicine technologist or approved surgeon with a single intradermal injection in the upper outer quadrant, adjacent to the nipple, at the circumareolar margin
- *NOTE: It is imperative to inject 50 mcg mass of the drug (tilmanocept). The pharmacy will provide 50 mcg total, regardless of mCi amount. If the dose is a little high in mCi, you will need to have the radiologist sign off because though it is high in mCi it contains the 50 mcg of tilmanocept required. Therefore, do not remove any volume to reduce the mCi because this would not deliver the required mass of tilmanocept.*
- No imaging is performed in Nuclear Medicine

### **Protocol- melanoma:**

- Melanoma injections are performed by the nuclear medicine technologist around the melanoma site. There are two options for administration, either two or four intradermal injections. For two injections, they are to be spaced evenly at either 3 and 9 o'clock or 12 and 6 o'clock positions. For four injections, they are to be spaced evenly at 12, 3, 6, and 9 o'clock positions surrounding the lesion.
- *NOTE: It is imperative to inject 50 mcg mass of the drug (tilmanocept). The pharmacy will provide 50 mcg total whether we order two or four injections, regardless of mCi amount. Therefore, it is necessary to inject the total amount in the syringes that we receive from the pharmacy. If the dose is a little high in mCi, you will need to have the radiologist sign off because though it is high in mCi, it contains the 50 mcg of tilmanocept required. Therefore, do not remove any volume to reduce the mCi because this would not deliver the required mass of tilmanocept.*
- Images should begin immediately after injection.
- Images should be done every 5 minutes.
  - Back- axilla, groin, and neck
  - Legs- pelvis and posterior knees

- Arms- axilla, neck, elbow
- Throughout the imaging, take transmission films with the cobalt sheet source to outline the body.
- Mark the patient's skin where the sentinel lymph node is on film with surgical marker at the end of the exam

**Processing:**

- Snapshot images and send to PACS for review

## MUGA

### Isotope:

Tc99m RBC's

### Adult Dose:

30 mCi Tc99mUlratag RBC

Order 40mCi Tc99mO4- to use for tagging the red blood cells.

### Indications:

- CAD, CHF, chemo.

### Patient Prep:

- None

### Exam Time:

- Initially 45 mins

### Equipment and Energy:

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

### Protocol:

- Draw 3mL of blood from patient and tag using the Ultra tag kit
- When the blood is ready position the patient on the table.
- EKG electrodes are placed. Make sure the R wave produces a positive and clear voltage spike to the computer.
- Reinject the patient.
- Take LAO image at 45 degrees
- Take Anterior image

### Processing:

- Process the images with the computer program to calculate the EF for the left ventricle using the LAO image.