

# **GUNDERSEN LUTHERAN NUCLEAR MEDICINE DEPARTMENT PROTOCOL MANUAL**

**PROCEDURE:                      PERFUSION AND VENTILATION LUNG SCAN**

**SECTION:                         PULMONARY                      8.0**

**ORIGINAL DATE:                9 – 18 - 18**

**DATE REVISED:                4 – 29 - 21**

**REVIEWED:                      ANNUAL**

During the duration of the Covid-19 episode:

## **All Lung scans will be done in NM Room 3-**

In order to try to decrease the number of ventilation portions being performed, we will be perfusing the patient first and checking the images with the reading radiologist to determine whether the ventilation portion will be needed.

Therefore:

- For our lung scan we will order 2 mci 99mTc-MAA for the perfusion portion and 100 mci 99mTc-DTPA (calibrated 1 hr. after perfusion)
- We will SPECT the perfusion study.
- If needed, we will vent the patient with 80 to 100 mci through the vent kit. The vent time will be longer, 8-10 minutes so the count rate is at least 3-4 time higher.  
SPECT will then be done on the ventilation

Don PAPR for all lung scans when performing the ventilation on the patient. This is due to the fact that administering a positive pressure of oxygen into a patient has the potential of droplet exposures.

Scanning and performing the Perfusion procedure does not require the PAPR, however you should follow universal precaution protocol when appropriate.

## **Indications**

- Diagnosis of pulmonary embolism
- Evaluation of regional pulmonary perfusion
- Evaluation of hepatopulmonary syndrome
- Evaluation of Lung ventilation

## **Examination Time**

- 30 minutes for perfusion study
- 30 minutes for the post-perfusion ventilation study

## **Patient Preparation**

- Recent (within 24 hours) chest x-ray. Ask reading radiologist to view the chest x-ray prior to beginning the perfusion exam.
- No chest x-ray is needed if patient has HI RES CHEST CT scheduled.

### **Perfusion:**

- Patient **MUST** be injected in a recumbent position during the injection of the MAA.
- For Severe Pulmonary Hypertension—Inject <500,000 particles, adjust kit. (instructions located in Hot Lab);
- \*\*\* Pediatric patients, Pt's with Right to Left shunts, or Pneumonectomy should receive less particles. Refer to Package Insert for details.

### **Ventilation:**

- The aerosol ventilation study is performed after the perfusion study
- Rehearse the breathing procedure to assure optimal patient cooperation; instruct the patient to breathe by mouth only.
- Imaging should be done in the same position (upright or supine) for the Static perfusion imaging.

## Equipment & Energy Windows

Gamma camera: Large field of view.

Collimator: Low energy, High Resolution, parallel hole. (LEHR)

Energy window: 20% window centered at 140 keV.

## Radiopharmaceutical, Dose, & Technique of Administration

### Perfusion:

Radiopharmaceutical: Tc-99m-macro aggregated albumin.  
Adjust particle number for Pediatric patients, use table below.

Dose:

Perfusion *before* Ventilation or Perfusion Only

Adult: 2.0 mCi

Pediatric: 0.03 mCi/kg (Minimum: 0.4 mCi, Maximum: 3.0 mCi)

Perfusion *after* Ventilation

Adult: 5.0 mCi

Pediatric: 0.07 mCi/kg (Minimum: 0.4 mCi, Maximum: 5.0 mCi)

### Pediatric Particle Range

Age	Newborn	1 year	5 years	10 years	15 years
Range of Particles Administered	10,000- 50,000	50,000- 150,000	200,000- 300,000	200,000- 300,000	200,000- 700,000

Technique of administration: Standard intravenous injection.

### Patient Position & Imaging Field

Patient position: Supine

Imaging field: Entire lungs.

### **Ventilation:**

Radiopharmaceutical: Tc-99m-DTPA aerosol in concentration of 15-20 mCi/ml, with a minimum of 2 ml.

Dose: Adult: 80 - 100 mci 99mtc-DTPA (calibrated 1 hr. after perfusion).  
Pediatric: 1.6 mci/kg (Dosing range of 20 to 80 mCi)

Ventilation can be performed upright or supine. Estimated vent time of 7-10 minutes so the count rate is at least 3-4 time higher.

Technique of administration: Via a positive pressure nebulizer:

1. Patient education is very important. Carefully explain exactly what will be happening during ventilation to the patient. It is preferable for the patient to be upright while inhaling the aerosol, but the patient can be supine if necessary.

Note: Explain numbers 2 through 4 to the patient prior to beginning procedure.

2. Place the mouthpiece in the patient's mouth.
3. Place the nose clip on the patient's nose.
4. Turn on the oxygen, instruct the patient to take normal breaths from the system.
5. Add 99mTc DTPA to nebulizer.
6. Gradually turn on the oxygen to the desired flow rate, 10-12 L/min. (An abrupt increase may cause detachment of the airline from the unit.)  
Stay with the patient and monitor breathing process continuously.
7. The patient should breathe normally until the desired amount of radioactivity is delivered to the lungs. Be prepared to shut off the oxygen flow immediately if the patient releases the mouthpiece.

The patient breathes for 2 – 3 minutes, when the aerosol study is performed first. Camera count rate 1-3K.

8. After inhalation, turn off the oxygen and instruct the patient to continue breathing through the mouthpiece for additional four or five tidal breaths to clear the system of aerosol.

9. Remove the nose clip and mouthpiece from the patient. Have patient expel any excessive saliva into disposable towel to minimize gastric radioactivity. If patient is coughing excessively after finishing with nebulizer, a mask (non-sterile, procedure) may be used to contain any possible Tc-DTPA contamination.

If there is any question of contamination during or following the ventilation process, please refer to 'NM Spill Policy 1.59' for guidance.

10. The patient imaging procedure may be started as soon as convenient.

### **Acquisition Protocol**

For both Perfusion and Ventilation acquire SPECT/CT Imaging( statics as Radiologist directed) :

Position patient with arms above head; 'Tomo Perfusion' and 'Tomo Ventilation'

-If unable to bring arms up: 'Tomo P-ARMS DOWN' and 'Tomo V-ARMS DOWN'

For *Infinia System Rm. #2* or as Radiologist directed: Acquire Static analog images in the POST, LPO, L LAT, LAO, ANT, RAO, R LAT, and RPO projections

Acquire each image for approximately 700 K counts (Laterals 500 K) or 5 Minutes

Lung Ventilation/Perfusion	
Time interval between tracer injection and imaging	Immediate after each Radiopharmaceutical is administered
Camera/Collimator	LEHR
Patient position	Supine
Energy	140 kev
Matrix	128 X 128
Pixel size	1.1 mm
Number of projections	60 6 deg/view 30 / Head
Orbit CW or CCW	CW or CCW
Orbit type	Body Contour Circular
Start Angle	0 deg
End Angle	360 deg from start
Time per view Ventilation ; Perfusion - Arms up	25 sec/view ; 15 sec/view
Time per view Ventilation ; Perfusion - Arms down	30 sec/view ; 20 sec/view
Gating (Y/N)	NA
Gating frames	NA
R to R window	NA
Uniformity and COR	Daily / Weekly
Prefilter Type	Hanning
Filter cutoff/power	0.9
Motion correction	No – Repeat if motion
Attenuation correction Y/N	Y CT
Normal database used Y/N	Y Use MI Evolution for Soft tissue
Reconstruction filter	OSEM
Screen caps to make	Planar statics
Send to FUJI	CT, MIP, Trans Emission, Trans Fused

## Data Processing (for Perfusion and Ventilation Static images)

### Lung Analysis Processing

1. Perfusion SPECT/CT
  - a. Highlight patient. Selecting TOMO P, CT TOMO P
  - b. Select Volumetrix MI Evolution Tc99m, Soft Tissue CT Window
  - c. Hybrid QC is presented. Check that data is aligned using the red threshold ROI's. Adjust using window level as needed. CLK proceed (Left of screen). All reconstruction using OSEM.
  - d. View IRNC to Hybrid CT page. Ensure the red limits reflect proper fused data.  
If yes, click "Passed" and allow to process.
  - e. Click "File", then "Save MIP".
  - f. Click "File" then "Save as Partial Volume"
  - g. Click "File", then "Save & Exit"
  - h. For Ventilation SPECT follow steps a-g, choosing Ventilation data.
2. Perfusion and/or Ventilation statics
  - a. On Xeleris functional imaging workstation, go to All Applications
  - b. Choose pulmonary tab
  - c. Choose lung analysis once you've highlighted your patient, hit start
  - d. Perfusion
    - i. Perfusion image review
    - ii. R lung and Ref images
    - iii. L lung and Ref images
    - iv. Quant Perf analysis
  - e. Ventilation
    - i. Static image review
    - ii. R lung and Ref images
    - iii. L lung and Ref images
  - f. Vent/Perf
    - i. Static image review
    - ii. Post/rao/rlat/rao & Ref images
    - iii. LPO/LLAT/LAO/ANT& Ref images

Choose menu item **#1 for Vent/Perf SPECT/CT** scans. Send SPECT/CT processed images to FUJI PACS

Choose menu item **#2 for Perfusion only** lung scans and use options '2d.i.-iii.' to display the data, screen capture each page of images

Choose menu item **# '2d iv.' for Lung Quant scan** to display the data.

1. Under perfusion menu choose quantitative perfusion analysis
2. Follow prompts to adjust ROI over left lung as directed by Radiologist and proceed.
3. Follow prompts to adjust ROI over right lung as directed by Radiologist and proceed.
4. Make a screen capture of the data.  
Save screen captures to Fuji PACS, followed by images.

## Optional Maneuvers

1. **Quantitation: Perfusion Only- No Ventilation required (per Dr. Manske 8/20/15);** Unilateral or regional pulmonary function may be quantitated.

Views: Acquire only the Anterior and Posterior images for quantitation calculations.

Check with ordering physician to determine which areas of the lung he/she is interest wants ROIs drawn around.

References: JNM, Vol. 48, No5, May 2007

2. **Hepatopulmonary syndrome:**

Acquisition/Processing	
Time interval between tracer injection & imaging	None
Collimator	LEHR
Patient position	supine
Energy	140 keV
Matrix	1024*256
Scan Mode	Continuous
Time /View	Optima 1 + 2: 300 sec exposure per pixel, 10 cm/min; Infinia 4: 240 sec exposure per pixel, 8 cm/min
Start position	Just above top of head
End position	Mid-thigh
Images taken	Anterior and Posterior WB
Screen caps to make	Display Anterior and Posterior WB images. Create ROI's over entire body, lung field, and brain. Capture the statistics for WB, lungs and brain ROIs. Calculate the WB count total. Calculate Lung count total. Calculate brain count total. Subtract lung from WB, then divide by WB, report out the percentage in WB and in Lungs. Subtract brain from WB, then divide by WB, report out the percentage in brain.
Send to FUJI	Screen cap of images with ROI overlays. annotate statistics onto screen cap: X% of total activity in Lungs. X% of total activity outside of lungs. X% of total activity in brain. References: N Engl J Med 2008;358:2378-87. Eur J Gastroenterol Hepatol. 2010 Aug;22(8):1006-12.



## VQ PROTOCOLS

(utilizing DRAX MAA assuming 5 M particles per vial)

**Routine VQ:** Do Vent first as usual , with 40 – 60 mCi in nebulizer. Breath for 2 – 3 minutes, yielding count rate of 2 to 3 kps.

MAA dose : 5 mCi .

MAA Prep: add 50 mCi, 5 mCi dose will have 500K particles.

**Severe pulmonary HTN:** Do Vent first as usual, with 40 – 60 mCi in nebulizer. Breath for 2 – 3 minutes, yielding count rate of 2 to 3 kps.

MAA dose : 5 mCi with < 500K particles.

MAA Prep: add 50 mCi, 5 mCi dose will have 500K particles.

**Cardinal unit doses:** routine and severe pulmonary HTN

Do Vent first as usual, order 50 mCi DTPA (any dose above we get charged 2x) . Breath for 2 – 3 minutes, yielding count rate of 2 to 3 kps.

MAA: order 5 mCi. For severe pulmonary HTN specify < 500K particles in 5 mCi.

**NOTE:** The particle number you administer will increase as kit decays. Please recalculate particles if kit has decayed prior to drawing dose.