

LUNG VENTILATION/PERFUSION SCAN PLANAR with optional Differential Quantification CPT CODE: 78582, 78598
LUNG PERFUSION SCAN ONLY with optional Quantification CPT CODE: 78580, 78597

UPDATED: JANUARY 2019

Indications:

- Diagnosis of acute and chronic pulmonary embolism
- Evaluation of chronic obstructive pulmonary disease
- Assessment of relative ventilation and perfusion in various congenital, degenerative, and/or iatrogenic diseases
- Evaluate regional perfusion prior to lung resection for tumor or various pulmonary diseases
- If the study is indicated to follow patients with proven or suspected PE, and previous V/Q or perfusion scans are available, then perfusion scanning alone may be appropriate provided there is no reason to suspect mucus plugging or any other cause that might result in change in ventilation.
- Evaluate lung transplants
- Please refer to the AUC (appropriate use criteria) for different clinical scenarios, Appendix 1

Patient Prep:

- VQ: Patient must have a chest x-ray or any CT Chest within 24 hours of the exam
- VQ: If VA patient, a chest x-ray (CD) must come with the patient to the department
- If pt is pregnant or nursing, consult with staff before proceeding (for a pregnant person recommend a half-dose perfusion scan)

Scheduling:

- V/Q
 - Allow 60 minutes for imaging time
- V/Q with Optional Differential Quantification
 - Allow 45 minutes for imaging time for ventilation (day 1).
 - Allow 45 minutes for imaging time for perfusion (day 2).
 - Pt is scheduled for ventilation on day one and is to return two days later for perfusion imaging to allow for radiopharmaceutical clearance.
- Perfusion only or Perfusion with optional quantification
 - Allow 45 minutes for imaging and processing time.

Radiopharmaceutical

& Dose:

- Ventilation: 20 mCi (+/- 20%) Tc99m-DTPA, not adjusted for weight (future review to include 99mTc SC or PYP).
- Perfusion with ventilation scan: Minimal dose is 4.0 mCi (+/- 20%) Tc99m-MAA (Macroaggregated albumin) with 200-700K particles per dose. Dose adjusted for patient weight when above 90 kg as well as all pediatrics (refer to NMIS or nomogram).
- Perfusion without ventilation scan: 4.0 mCi (+/- 20%) Tc99m-MAA (Macroaggregated albumin) with 200-700K particles per dose. Dose adjusted for patient weight as well as all pediatrics (refer to NMIS or nomogram).

Caution:

Severe adverse reactions including deaths have been reported when patients with severe (patient with visible breathing difficulties) pulmonary hypertension were administered Tc-MAA. Assuming Tc-MAA is prepared per pharmacy protocol the previous kit prep of less than 4 hours is no longer valid.

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Data Acquisition:

1. Imaging Device
 - GE Infinia Hawkeye I, II, III, Optima (dual head preferred) or MPS (if needed)
 - For MPS refer to MPS section
 - LEHR Collimator
2. Imaging Procedure
 - A Nuclear Medicine Technologist will verify two forms of ID (DOB, spelling of name, MRN) and give a description of the exam.
 - Supine is the preferred imaging position, however, if the patient has difficulty lying down consider upright imaging if the scan is at risk of being canceled due to this discomfort.

VENTILATION (with or without differential quantification)

- Attach ventilation tubing to the aerosol canister.
- Use the face mask or mouthpiece as you deem appropriate for each patient.
 - If using the mouthpiece, be sure to have the white nose clamp on before delivering airflow to the system.
 - For a patient on a ventilator, use the adaptor and follow the Vision BiPAP Setup as noted in **2.09 Guidelines for Administration of Invasive & Noninvasive Respiratory Support in Nuclear Medicine Procedures** included at the end of this protocol (Appendix 2).
- Load the radioaerosol delivery system with 20mCi (+/- 20%) Tc^{99m}-DTPA and bring the reservoir volume to ~2.5ml using 0.9% NaCl.
- With the patient in an upright position (preferred), place the mouthpiece and nose-clamp or face mask onto patient.
 - Supine position can be used when necessary.
 - Annotate the inhalation position on the screen cap.
- Connect oxygen tubing from the wall to the aerosol canister.
- Deliver radioaerosol to patient at a flow rate of 10-12L/min for approximately 4minutes.
 - Instruct the patient to breath normal while taking occasional deep breaths.
 - If using the mouthpiece, make sure the patient keeps their lips as tight as possible to avoid the spreading of the radioaerosol.
- Once the ventilation is complete turn off the oxygen and have the patient take additional breaths through the system for 15-30seconds.
- Place ventilation components into the yellow bag and label the bag before placing it into storage for decay.
- Imaging can begin immediately.
- Patient should be positioned supine feet first.
- Have patient arms out of the field of view if possible for all images.
- Consult a Nuclear Medicine staff of resident regarding limited images or if arms will be in the field of view.

The following views are routinely acquired for 100k counts or 3 minutes, whichever comes first with a 256x256 image matrix and a 1.33 zoom

1. Anterior/Posterior
2. RAO/LPO
3. RLAT/LLAT
4. RPO/LAO

PERFUSION (with or with ventilation, with or with quantification)

- Perfusion images begin
 - VQ: Immediately after ventilation images.
 - VQ with Differential: starts minimally the day after tomorrow.
- The patient must be supine when injecting the 99mTc-MAA.
 - When contraindicated, consult with a Nuclear Medicine Staff or resident, and make a notation denoting the position used for injection.
- Prior to injecting 99mTc-MAA, have the patient take several deep breaths to increase the alveolar tension. Invert the MAA syringe several times before injecting.
- Inject over 3-5 seconds and begin imaging immediately.

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The Following views are routinely acquired using a 256x256 image matrix and a 1.33 zoom

1. Anterior/Posterior (800k counts)
2. RAO/LPO (700k counts)
3. RLAT/LLAT (600k counts)
4. RPO/LAO (700k counts)

3. System Setup VQ with or without differential quantification

GE Infinia Hawkeye I, II or III or Optima

To manually enter the patient:

- Click New Study tab.
- Enter the correct patient information.
- Click Select Study Protocol tab, then select USER tab.
- Select UW LUNG tab, then select LUNG VQ tab. Click OK.
- Verify the views and counts per view are each correct.

For automatic patient entry:

- Click the Filter tab, then enter the UWHC Accession Number and click Query.
- Look for the patient study on the work-list and click Acquire Study.
- Confirm that the correct patient information and study information is correct before beginning.
- Follow the same ventilation/perfusion set up and radioisotope administration as mentioned above

MPS Imaging System

- Click Worklist tab and enter the UWHC Accession number to bring up the correct patient.
- Click on the patient and then click Add To Do tab.
- Highlight patient in To Do tab and click Add, then Study.
- Select the U of W Lung V/Q tab, then V/Q CW.
- Patient must be placed supine head first.
- Select Camera On and begin taking the planar images.

VENTILATION

- Follow the same ventilation set up and radioisotope administration as mentioned above.
- Start with POST VENT and rotate camera counterclockwise following the order set up in the acquisition protocol.
 - RPO should be the last image taken for the 8 ventilation statics.

PERFUSION

- MAA administration is the same as mentioned above for the GE Infinia/Optima section.
- The same 8 views are to be taken as mentioned above.
- The first view should be LPO PERF and the camera then rotated clockwise in order to finish with the POST PERF view.

4. System Setup Perfusion with or without quantification

GE Infinia Hawkeye I, II or III or Optima

To manually enter the patient:

- Click New Study tab.
- Enter the correct patient information.
- Click Select Study Protocol tab, then select USER tab.
- Select a UW LUNG tab, then select LUNG PERF tab. Click OK.
- Verify the views and counts per view are each correct.

For automatic patient entry:

- Click the Filter tab, then enter the UWHC Accession Number and click Query.
- Look for the patient study on the work-list and click Acquire Study.
- Confirm that the correct information and study information is correct before beginning.

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MPS Imaging System

- Click Worklist tab and enter the UWHC Accession number to bring up the correct patient.
- Click on the patient and then click Add To Do tab.
- Highlight patient in To Do tab and click Add, then Study.
- Select the Lung tab, then Lung Perfusion statics.
- Patient must be placed supine head first.
- Select Camera On and begin taking the planar images.

- MAA administration is the same as mentioned above for the GE Infinia/Optima section.
- The same 8 views are to be taken as mentioned above.
- The first view should be LPO PERF and the camera then rotated clockwise in order to finish with the POST PERF view.

Data Processing:

Perform processing on Xeleris System.

- Processing will be the same for any imaging system the study is performed on.
- Highlight the patient raw data and click on the All Applications tab. Then click on the Pulmonary tab, then the Lung Analysis tab.
- All Save Screens should be saved using DatabaseStudy1024Color setting.

STANDARD VQ

- Under Vent/Perf tab, save screen;
 - Static Image Review and screen cap as **Vent/Perfusion Images**
 - Post/RPO/RLAT/RAO and Ref, screen cap as **V/P/Ref:POST/RPO/RLAT/RAO**
 - LPO/LLAT/LAO/ANT and Ref, screen cap as **V/P/Ref:LPO/LLAT/LATO/ANT**

PERFUSION ONLY

- Click on the Perfusion tab, which is the first tab from the left.
 - Save Screens to be created
 - Perfusion Images
 - Right Perfusion & Ref Images
 - Left Perfusion & Ref Images

PERFUSION QUANTITATIVE

- Click on Quant Analysis.
- Adjust Posterior Left Lung ROI box so that the entire lung fits into box and click proceed.
- Adjust Posterior Right Lung ROI box and click proceed.
- Repeat for both Anterior views and click proceed.
- Repeat for Perfusion images.
- Save screen the results page as **Quant:Perf Analysis:Geom. Mean.**

VENTIALLATION QUANTITATIVE (when VENTILATION/PERFUSION DIFFERENTIAL QUANTITATIVE ORDERED)

- Select Ant_V and Post_V images ONLY.
- Click on UW LUNG QUANT processing protocol.
- Click on Quant Analysis.
- Adjust Posterior Left Lung ROI box so that the entire lung fits into box and click proceed.
- Adjust Posterior Right Lung ROI box and click proceed.
- Repeat for both Anterior views and click proceed.
- Select the Annotation tab (left side of screen)
- Under Image Label select None from the drop-down menu.
- Save screen the results page as Ventilation **Quant:Perf Analysis:Geom. Mean.**

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PACS:

Send all images to ALI

- raw ventilation and/or perfusion data
- anatomical screens caps
 - 2 for VQ
 - 2 for Perfusion
- quantification screen caps if perform
 - 2 for VQ Differential Quantification
 - 1 for Perfusion Quantification

Interpretation:

- No PE is reported if there is (are):
 1. Normal perfusion pattern conforming to the anatomic boundaries of the lungs.
 2. Matched or reversed mismatch V/Q defects of any size, shape or number in the absence of a mismatch.
 3. Mismatch that does not have a lobar, segmental or sub segmental pattern.
- PE is reported if there is:
 - V/Q mismatches of at least one segment or two sub segments that conforms to the pulmonary vascular anatomy.
- The tracer will be in the systemic and pulmonary circulation. Both anterior and posterior computer acquisitions will allow quantitation of the degree of shunting. The brain and kidneys are sites easily recognized on the images if shunting is minimal.

Appendix 1

TABLE 1
Clinical Scenarios for PE in Adults

Scenario no.	Description	Appropriateness	Score
1	PE unlikely, D-dimer negative	Rarely appropriate	1
2	PE likely, D-dimer negative	Appropriate	8
3	PE unlikely, D-dimer positive	Appropriate	8
4	PE likely, male or nonpregnant female with normal chest radiograph	Appropriate	9
5	PE likely, male or nonpregnant female with mild abnormal chest radiograph	Appropriate	9
6	Suspected PE, male or nonpregnant female with significant abnormal chest radiograph	May be appropriate	5
7	PE likely, patient with abnormal renal function	Appropriate	9
8	PE likely, patient at risk for contrast complication	Appropriate	9
9	PE likely, patient who cannot cooperate for ventilation imaging, perfusion only	May be appropriate	5
10	PE likely, CTPA inconclusive or discordant with clinical probability	Appropriate	9
11	PE likely, hemodynamically unstable patient, portable V/Q equipment available	Appropriate	7
12	PE likely, hemodynamically unstable patient, portable V/Q equipment unavailable	Rarely appropriate	1
13	PE likely, ultrasound of lower extremity with clot	Appropriate	9
14	PE (clinically) unlikely, ultrasound of lower extremity with clot	May be appropriate	5
15	PE likely, pregnant patient with normal/mild abnormal chest radiograph, low-dose perfusion only	Appropriate	9
16	PE likely, pregnant patient with severe abnormal chest radiograph, perfusion only	Rarely appropriate	3
17	PE likely, patient ventilator-dependent	May be appropriate	5
18	Recent/prior documentation of PE with CTPA, suspected new PE	Rarely appropriate	2
19	Recent/prior documentation of PE with V/Q scan, suspected new PE	Appropriate	9
20	Recent documentation of PE by CTPA, patient now on anticoagulation; imaging to document disease status when clinically indicated	Rarely appropriate	2
21	Recent documentation of PE by V/Q scan, patient now on anticoagulation; imaging to document disease status when clinically indicated	Appropriate	9

PE likely or unlikely is determined by the referring clinician.

Waxman et al, Appropriate Use Criteria for Ventilation-Perfusion Imaging in Pulmonary Embolism. (2017). *Journal of Nuclear Medicine and Molecular Imaging*,58(5), 4-4.

Appendix 2 (Check U-Connect if needed for most current version)

2.09 Guidelines for Administration of Invasive & Noninvasive Respiratory Support in Nuclear Medicine Procedures

Category: UWHC Patient Care Policy

Effective Date: January 1, 2016

Version: Revision

Section: Mechanical Ventilation

I. PURPOSE

Aerosolized radio-tagged media (Tc 99m DTPA) is delivered via positive pressure ventilation or BiPAP/CPAP support to assess ventilation distribution within the lung. V/Q scans are done to image lung ventilation versus perfusion. Respiratory Therapy (RT) provides mechanical ventilation or continuous CPAP support during the test. Ventilator or CPAP parameter changes assure ventilation is adequate and the V/Q scan is optimized.

II. POLICY

- All patients are assessed by the RT to determine if appropriate indications for therapy are present.
- V/Q scans will be performed in accordance with a provider's order.
- PneuPac Transport ventilators cannot be used during the V/Q procedure.
- NMT will provide a full face resuscitation mask for non-intubated patients. Nasal masks should not be used for this procedure.
- The NMT will discard the resuscitation mask.
- V/Q scans must be done only with a shielded nebulizer system dedicated to this procedure.

EQUIPMENT

- The Nuclear Medicine Technologist (NMT) will provide the following equipment:
 - Shielded, disposable nebulizer
 - Disposable resuscitation mask for non-invasive mechanical ventilation and CPAP
 - Extra high pressure extension tubing (stored in E1/392)
- Noninvasive BiPAP/CPAP system
- Critical care ventilator or Hamilton transport ventilator

PROCEDURE

- NMT responsibility: (Content is provided to delineate practitioner responsibilities for this test.)
 - Stores, prepares, assures correct dosage and administers radio-tagged media to patients according to written protocol.
 - Assures minimal exposure to patients and health care workers from radiation.
 - The aerosol generator is a single patient use item; discarded by the NMT after use employing appropriate techniques for disposing of nuclear biohazardous material.
 - Once the media is instilled into the nebulizer, the shield must be immediately closed and not reopened to avoid radiation exposure. The nebulizer gas connection must be secure prior to closing shield. The nebulizer must also be seated into the oxygen inlet carefully to avoid breakage and resultant leakage of media.
 - Sets nebulizer gas flow at 8 lpm and communicates this flow to the RT. Nebulization can take from 5 to 10 minutes.
 - Assures the proper disposal of nuclear media and contaminated disposable items.
 - Stores all contaminated reprocessed equipment to allow the decay of nuclear material prior to sending the equipment to reprocessing.
- RT responsibility:
 - Use extra high-pressure tubing (stored room E1/392 in the Nuclear Medicine area) if the ventilator air/oxygen high-pressure tubing is not long enough to reach the needed ventilator placement. Return the tubing to the storage area when done.
 - Attach the ventilator wye or BiPAP or CPAP tubing with exhalation valve to the aerosol manifold on the top of the lead canister shield
 - The BiPAP/CPAP circuit will be shortened by the NMT. (See related link).

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- Adjust patient ventilation parameters as tolerated by the patient and as needed to improve imaging.
 - Adjust set ventilator tidal volume to compensate for the additional nebulizer gas using peak pressure as the reference. Retaining a slightly larger delivered tidal volume could be desirable to negate system mechanical dead space and/or improve aerosol distribution.
 - Other options available to improve distribution and deposition of the diagnostic aerosol (to be used as needed) include:
 - Using the lowest respiratory rate tolerated.
 - Using the lowest flowrate (i.e.: longest inspiratory time) tolerated.
 - Using the longest pause time tolerated.
 - Bypassing (and turning off) the heated humidifier for the duration of the media aerosolization.
 - Return all modified ventilator or CPAP settings to baseline after the aerosol delivery is completed and perform a complete ventilator check.

III. REFERENCES

- A. CADEMA Nuclear Medicine Aerosol System illustration.
 - B. UWHC Nuclear Medicine Department P&P: Ventilation Lung Scan-Aerosol.
- Approved by Director and Medical Director of Respiratory Care:
A copy of this Policy & Procedure is available in the Respiratory Care Office [E5/489].

Appendix 2 continued

Ventilator Setup



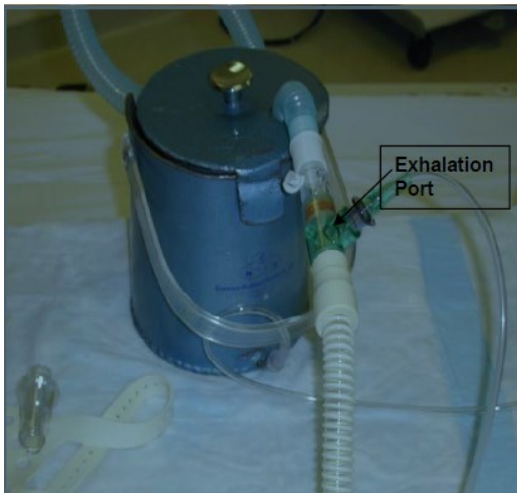
**Expiratory
Filter**

No HME

Heater Shut Off

J:/Resp/Policy related link/1-13

Non-Invasive Setup



J:/Resp/Policy related link/1-13

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References

Waxman et al, Appropriate Use Criteria for Ventilation-Perfusion Imaging in Pulmonary Embolism. (2017). *Journal of Nuclear Medicine and Molecular Imaging*,58(5), 4-4.

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