SCINTIGRAPHY OF THE LUNGS
THE “VQ” SCAN

By George N. Sfakianakis, M.D.
Professor of Radiology and Pediatrics  October 2009
PULMONARY EMBOLISM

94,000 cases annually in US.

Not a disease by itself.

A potentially fatal complication of deep venous thrombosis.

Effective therapy is available, associated with significant morbidity.

Accurate diagnosis is paramount.
RISK FACTORS FOR THROMBOEMBOLIC DISEASE

Virchow’s triad:

- Venous stasis.
- Hypercoagulability.
- Endothelial damage.
# Table 2. Reported Risk Factors for Thromboembolic Diseases.

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>No. of Patients</th>
</tr>
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<tbody>
<tr>
<td><strong>High risk</strong></td>
<td></td>
</tr>
<tr>
<td>Immobilization $&gt;3$ days</td>
<td>1*</td>
</tr>
<tr>
<td>Recent surgery (within past 3 wk)</td>
<td>1*</td>
</tr>
<tr>
<td>Multiple trauma</td>
<td>0</td>
</tr>
<tr>
<td>Previous deep venous thrombosis or pulmonary embolism</td>
<td>3*</td>
</tr>
<tr>
<td>Cancer</td>
<td>1</td>
</tr>
<tr>
<td>Pregnancy or postpartum period</td>
<td>0</td>
</tr>
<tr>
<td>Heart failure</td>
<td>2</td>
</tr>
<tr>
<td>Coagulation disorders</td>
<td>0</td>
</tr>
<tr>
<td><strong>Moderate risk</strong></td>
<td></td>
</tr>
<tr>
<td>Varicose veins</td>
<td>14</td>
</tr>
<tr>
<td>Estrogen or progesterone treatment</td>
<td>18</td>
</tr>
<tr>
<td>Age $&gt;40$ yr</td>
<td>49</td>
</tr>
<tr>
<td>Obesity</td>
<td>5</td>
</tr>
<tr>
<td>Tobacco use</td>
<td>4</td>
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<tr>
<td>Nephrotic syndrome</td>
<td>0</td>
</tr>
</tbody>
</table>

*One patient reported undergoing recent surgery for varicose veins associated with immobilization.
Figure 1. Cases of Deep-Vein Thrombosis per 10,000 Person-Years, According to the Use of Oral Contraceptives and the Presence of Factor V Leiden.
Severe Pulmonary Embolism Associated With Air Travel


Conclusions: A greater distance traveled is a significant contributing risk factor for pulmonary embolism associated with air travel.
Incidence of Pulmonary Embolism (per 1 million passenger arrivals)

Flight Distance (km)

- <2500: 0.00
- 2500-4999: 0.11
- 5000-7499: 0.40
- 7500-9999: 2.66
- ≥10,000: 4.77
**Paradoxical Embolus**

An 18-year-old woman who had flown from England to the United States presented to the emergency room with shortness of breath and numbness of the right arm. She had been taking oral contraceptives until two months before presentation. A computed tomographic (CT) pulmonary angiogram reformatted in the coronal orientation showed numerous filling defects within the main pulmonary arteries (arrowheads in Panel A) consistent with the presence of pulmonary emboli, as well as a filling defect in the right subclavian artery at the branch of the vertebral artery (long arrow) consistent with the presence of a systemic arterial embolus and accounting for the symptoms in her right arm. The finding of an opacity at the left costophrenic angle (short arrow in Panel A) was suggestive of pulmonary infarction, classically described as "Hampton's hump" when seen on chest radiography. A patent foramen ovale (arrow in Panel B) was identified, from which dense contrast material was leaking from the right atrium (RA) to the left atrium (LA); this finding was confirmed by transesophageal echocardiography. The right atrium was enlarged as a result of elevated pulmonary pressure, and there were additional emboli in lower-lobe branches of the pulmonary arteries (arrowheads in Panel B). The emboli were most likely caused by deep venous thrombosis from the patient's legs. A CT image of the distal thighs showed a residual clot (arrow in Panel C) in the left distal superficial femoral vein. The patient's symptoms resolved after she underwent catheter-directed thrombolysis of the subclavian-artery embolus and received systemic thrombolytic treatment for the pulmonary embolism. The patent foramen ovale was closed. There was no obvious laboratory evidence of hypercoagulability.

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PATHOLOGICALY

Most emboli arise from lower limb DVT embolizing the lungs.

Potential result: increased pulmonary vascular resistance,

increased right ventricular pressure,

hypotension,

death.
### CLINICAL ALGORITHM FOR PULMONARY EMBOLISM

**Pre-test likelihood of PE:**
- Low 10-20%
- Intermediate 30-40%
- High 70-80%

#### Clinical Score by Wicki et al.\(^{33}\)

<table>
<thead>
<tr>
<th>Element</th>
<th>Points</th>
<th>Clinical Score by Walls et al.(^{91})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous PE or DVT</td>
<td>2</td>
<td>Previous PE or DVT</td>
</tr>
<tr>
<td>Heart rate &gt;100 beats/min</td>
<td>1</td>
<td>Heart rate &gt;100 beats/min</td>
</tr>
<tr>
<td>Recent surgery</td>
<td>3</td>
<td>Recent surgery/</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80-79 yr</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>≥80 yr</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>(P_{\text{aCO}_2})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;6.5 kPa</td>
<td>4</td>
<td>Hemoptysis</td>
</tr>
<tr>
<td>6.5-7.99 kPa</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>8.0-9.49 kPa</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>9.5-10.99 kPa</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Atelectasis</td>
<td>1</td>
<td>Cancer</td>
</tr>
<tr>
<td>Elevated hemidiaphragm</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

#### Clinical probability

<table>
<thead>
<tr>
<th>Probability</th>
<th>Likelihood</th>
</tr>
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<tbody>
<tr>
<td>Low</td>
<td>0.4</td>
</tr>
<tr>
<td>Intermediate</td>
<td>0.8</td>
</tr>
<tr>
<td>High</td>
<td>0.9</td>
</tr>
</tbody>
</table>

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\(^{33}\) Wicki et al. 1985

\(^{91}\) Walls et al. 1999
CLINICAL CRITERIA FOR PE FOR SIMPLIFIED VERSION OF PRETEST CLINICAL ASSESSMENT

Strong:
- Documented DVT.

Medium:
- History of PE or DVT,
- Surgery within past 3 months,
- Immobility for whatever reason,
- Age older than 60,
- Cancer,
- Thrombophilia.
CHEST XRAY FINDINGS IN PULMONARY EMBOLISM

Only 12% (45 of 383) of patients with angiographically documented PE had normal CXR.

Most common CXR findings:

- Atelectasis.
- Parenchymal opacities.
- Small pleural effusions.
- Focal lung oligemia.
- Changes of proximal pulmonary artery size.
IMPORTANCE OF CXR

Exclude some of the clinical imitators of PE such as pneumothorax, rib fracture, and pneumonia.

Essential correlative imaging for the V/Q lung scan.
VENTILATION-PERFUSION SCAN
PERFUSION SCAN PROTOCOL

Approximately 5 mCi of $^{99m}$Tc MAA is injected.

Patient injected supine to decrease the hydrostatic gradient between the upper and lower lung zones, present in upright position.

Particle size: mean $40 \mu m$ with a range of $10$ to $90 \mu m$, so that vessels up to the size of a terminal arterial can be occluded.

Number of particles injected: $100,000$ to $700,000$ ($<0.1\%$ occlusion of the peripheral arterial tree).
PERFUSION SCAN PROTOCOL

Static lung images performed in eight projections (some centers perform in six projections).

Most protocols require:

- 800K counts for the anterior and posterior projections.
- 700K counts for the oblique images.
- 600K counts for the lateral images.
VENTILATION SCAN

Ventilation studies are required to increase the specificity of the perfusion studies.

Possible radiopharmaceuticals:

- $^{133}$Xe.
- $^{127}$Xe.
- $^{81m}$Kr.
- $^{99m}$Tc aerosols.
- $^{99m}$Tc technegas.
- $^{99m}$Tc pertechnegas.
## PHYSICAL PROPERTIES OF VENTILATION RADIONUCLIDES

<table>
<thead>
<tr>
<th>Ventilation tracer</th>
<th>Physical Half-life</th>
<th>Gamma ray keV</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{81m}$Kr</td>
<td>13 sec</td>
<td>191</td>
</tr>
<tr>
<td>$^{99m}$Tc</td>
<td>6 hours</td>
<td>140</td>
</tr>
<tr>
<td>$^{133}$Xe</td>
<td>5.2 days</td>
<td>81</td>
</tr>
<tr>
<td>$^{127}$Xe</td>
<td>36.4 days</td>
<td>172, 203, 375</td>
</tr>
</tbody>
</table>
Ventilation Xe-133

Normal

Xe-133 Ventilation

Inhalation  Equilibrium  Wash out 1  Wash out 2
Ventilation $^{99m}$Tc-DTPA
Normal
TECHNETIUM-99m AEROSOLS

Most commonly used ventilation radiopharmaceutical today.

Delivered via commercially supplied nebulizer.

Droplet size:

– 1 to 3 µm delivered to the alveoli via sedimentation.

– Larger droplets deposited to oropharynx and large airways by impaction.

– Smaller droplets do not remain in the lungs.
TECHNETIUM-99m AEROSOLS

Technique:

- Images performed prior to the perfusion images.
- Approximately 1 mCi of radioaerosol administered from a trap containing approximately 40 mCi.
- Patient is breathing normally during the administration of the radioaerosol in front of the gamma camera until the counts reaches 2000 cps and tracer appears predominantly in the lungs.
- Multiple-view 100K count ventilation images.
Revised PIOPED Criteria for Pulmonary Embolism

- High probability
- Intermediate probability
- Low probability
- Very low probability
- Normal
High Probability

At least 2 large (> 75% of a segment) segmental perfusion defects without corresponding ventilation or CXR abnormalities.

1 large and at least 2 moderate segmental (25-75% of a segment) perfusion defects without corresponding ventilation or CXR abnormalities.

At least 4 moderate segmental perfusion defects without corresponding ventilation or CXR abnormalities.
Intermediate Probability

1 large and less than 2 moderate segmental perfusion defects without corresponding ventilation or CXR abnormalities.

Single moderate mismatched defect with normal CXR findings.

Corresponding V/Q defects and CXR parenchymal opacity in lower lung zone.

Corresponding V/Q defects and small pleural effusion.

Difficult to characterize as normal, low or high probability.
Low Probability

Multiple matched V/Q defects, regardless of size, with normal CXR findings.

Corresponding V/Q defects and CXR parenchymal opacity in upper and middle lung zone.

Corresponding V/Q defects and large pleural effusion.

Any perfusion defects with substantially larger CXR abnormality.

Defects surrounded by normally perfused lung (Stripe sign).

More than 3 small (<25% of a segment) segmental defects with a normal CXR.

Nonsegmental perfusion defects (cardiomegaly, aortic impression, enlarged hila).
Very Low probability

Up to 3 small matching segmental perfusion defects
with normal CXR

Normal

No perfusion defects and perfusion outlines
the shape of the lung seen on CXR.
### Interpretation

<table>
<thead>
<tr>
<th>Interpretation</th>
<th>Pattern</th>
<th>Pulmonary Embolism (%)</th>
<th>% Deaths from PE if Untreated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Normal Perfusion</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Probability of pulmonary embolism:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1. Small V/Q mismatches</td>
<td>0-8</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2. Focal V/Q matches with no</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>corresponding radiographic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>abnormalities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Perfusion defects substantially</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>smaller than radiographic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>abnormalities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>1. Diffuse V/Q match with ≥2/3</td>
<td>25-30</td>
<td>1-5</td>
</tr>
<tr>
<td></td>
<td>lung having abnormal V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Matching perfusion defects</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and radiographic abnormalities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Single moderate V/Q mismatch</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>without corresponding radiographic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>abnormality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>1. Perfusion defects (due to PE)</td>
<td>&gt;85</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>substantially larger than radiologic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>abnormalities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(due to hemorrhage or infarct within PE area)</td>
<td></td>
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<tr>
<td></td>
<td>2. One or more large, two or</td>
<td></td>
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<tr>
<td></td>
<td>more moderate-sized V/Q mismatches</td>
<td></td>
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<tr>
<td></td>
<td>with no corresponding radiographic</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>abnormalities</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### V/Q Lung Scan for PE

#### A. Perfusion Defect

<table>
<thead>
<tr>
<th>Normal Ventilation</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Normal Ventilation</td>
<td>HIGH</td>
</tr>
<tr>
<td>2. Matching Ventilation</td>
<td></td>
</tr>
<tr>
<td>a. Normal X-Ray:</td>
<td>LOW</td>
</tr>
<tr>
<td>b. Matching X-Ray:</td>
<td>INTERMEDIATE</td>
</tr>
</tbody>
</table>

#### B. Ventilation Defect(s)

1. Greater than 50% of Field
   - a. Normal(?) Perfusion: LOW
   - b. Matching Perfusion: INTERMEDIATE

2. Less than 50% of Field
   - a. Normal(?) Perfusion: LOW
   - b. Matching Perfusion: AS A2
Normal \((^{99\text{m}}\text{Tc-DTPA} / ^{99\text{m}}\text{Tc-MAA})\)
Normal \( { }^{99m} \text{Tc-MAA} / { }^{133} \text{Xe} \)
Normal \ (^{99}\text{Tc}-\text{DTPA} / ^{99}\text{Tc}-\text{MAA})
**High Probability (\(^{99m}\text{Tc-DTPA} / {^{99m}\text{Tc-MAA}}\))**

<table>
<thead>
<tr>
<th>Post</th>
<th>RPO</th>
<th>LPO</th>
<th>RAO</th>
<th>Ant</th>
<th>LAO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilation</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Perfusion</td>
<td></td>
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</table>

Chest X-Ray: Normal

Multiple mismatched defects indicating high probability of PE
High Probability ($^{99m}$Tc-MAA / $^{133}$Xe)

Chest X-Ray: Normal
Multiple mismatched defects indicating high probability of PE
High Probability (\(^{99}\text{mTc}\)-DTPA / \(^{99}\text{mTc}\)-MAA)

- Chest X-Ray: Normal
- Multiple mismatched defects indicating high probability of PE
High Probability ($^{99m}\text{Tc-DTPA} / ^{99m}\text{Tc-MAA}$)

Chest X-Ray: Normal
Multiple mismatched defects indicating high probability of PE
Low Probability ($^{99m}$Tc-MAA / $^{133}$Xe)

Matching V/Q and X-ray in right mid lung zone, but Lesion: Perfusion < X-ray
Low probability of PE ($^{99m}$Tc-DTPA / $^{99m}$Tc-MAA)

Ventilation in upper lung zones worse than perfusion, consistent with COPD
Chronic Obstructive Pulmonary Disease ($^{99m}$Tc-DTPA / $^{99m}$Tc-MAA)
Pulmonary Sequestration in a child ($^{99m}$Tc-MAA)
**Pulmonary Sequestration in a child \((^{99}\text{Tc-MAA})\)**

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*Images and diagrams showing the visualization of pulmonary sequestration with \(^{99}\text{Tc-MAA})*
28 yo lady with prominent pulmonary artery on chest radiograph
Receiver Operating Characteristic Curve for Diagnosis of Pulmonary Embolism
## Combined clinical and scan probability of PE

<table>
<thead>
<tr>
<th>Scan probability</th>
<th>Pre-test clinical probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High (80-100%)</td>
</tr>
<tr>
<td>High</td>
<td>96</td>
</tr>
<tr>
<td>Intermediate</td>
<td>66</td>
</tr>
<tr>
<td>Low</td>
<td>40</td>
</tr>
<tr>
<td>Near Normal</td>
<td>0</td>
</tr>
</tbody>
</table>

*PIOPED investigators. JAMA 1990;263:2753-2759.*
Causes of false-positive scans for Acute Pulmonary Embolism

Three most common causes:

- Chronic pulmonary embolism.
- Non-thrombotic emboli (such as talc).
- Lung cancer.

Other causes:

- Intravascular: tumor, fat, parasite.
- Vessel wall: Pulmonary stenosis, arteritis.
- Extrinsic compression: nodal enlargement, sequelae from radiation, interstitial lung disease.
UNILATERAL PERFUSION ON V/Q SCAN

- Bronchogenic carcinoma
- CHD s/p shunt procedure
- S/P Pneumonectomy
- Pulmonary embolus
- Severe parenchymal dz (i.e. TB)
- Swyer-James
- Injcn of Pulm artery catheter
- Pneumothorax
- Pulm artery hypoplasia/agenesis
- Bronchial obst (i.e. adenoma, FB, broncholithiasis)
- Mediastinal fibrosis/adenopathy
- Massive pleural effusion
CTA
COMPUTED TOMOGRAPHY ANGIOGRAPHY
CT ANGIOGRAPHY PROTOCOL

Multislice scanner used.

Performed with an injection-to-scan delay of 20 seconds.

Injection of 135 ml of low-osmolar nonionic contrast at 4 ml/sec (more for patients weighing >250 lbs).

Scan starts 2 cm below the lowest diaphragm and proceeds cranially to the top of the lung apex.

Images displayed at 3 different gray scale for interpretation: (1) lung windows (W=2000 HU and L=-500 HU), (2) mediastinal windows (W=450 HU and L=50 HU), and pulmonary embolus-specific setting (on basis of degree of contrast enhancement).
CT ANGIOGRAPHY INTERPRETATION

Diagnostic criteria for acute PE:

- Arterial occlusion, i.e., failure to opacify entire lumen because of central filling defect,
- Partial filling defect, surrounded by contrast (cross-sectional image).
- “Railway tracking,” i.e., there is a small amount of contrast between the central filling defect and artery wall (in plane, longitudinal image).
- Peripheral intramural defect; i.e., the eccentric filling defect makes an acute angle with the artery wall.
CT ANGIOGRAPHY INTERPRETATION

Diagnostic criteria for chronic PE:

- Complete occlusion, but that vessel is smaller than its peers.
- Eccentric or crescentic thickening or a vessel wall with obtuse angles to the wall.
- Contrast flowing through a thickened, often smaller artery (recanalization).
- Web or flap within contrast-filled artery.
- Secondary signs, i.e., extensive bronchial or other systemic collateral through that area, accompanying mosaic perfusion pattern on lung windows, or calcification within eccentric thickening.
SENSITIVITY AND SPECIFICITY OF CT ANGIOGRAPHY

When angiography used as gold standard:

- For 3-mm thick CT: sensitivity = 76%.
- For 1-mm thick CT: sensitivity = 81%.

When independent reference standard is used:

- Sensitivity for 3-mm and 1-mm CT = 82% and 87%, respectively.
- Sensitivity for conventional angiogram = 87%.
SENSITIVITY AND SPECIFICITY OF CT ANGIOGRAPHY

Meta-analysis with 11 studies:

- To the level of segmental pulmonary arteries: sensitivity = 80%
  and specificity = 86%.

- To the level of subsegmental pulmonary arteries: sensitivity = 71%
  and specificity = 89%.

*Harvey et al. Acad Radiol. 7:786-797.*
SMALL SUBSEGMENTAL PULMONARY EMBOLISM

Incidence of subsegmental PE between 20% and 36%.

Among 586 patients with normal cardiopulmonary reserve, intermediate VQ and negative ultrasound studies of the legs received no anticoagulants and the incidence of thromboembolic disease on follow up was 0.7% *.

Approximately 1% chance of recurrent PE at 3 months follow up according to published literature.

No death due to PE in patients having received no anticoagulant therapy with 6-months follow-up.

Alternating diagnosis found on CT in 54% of patients.
COMPARISON OF CT AND VQ SCAN

Two studies:

1) Van Rossum et al.: 123 patients having both CT angiogram and VQ scan irrespective of chest x-ray.

- CT scan: sens. 75%, spec. 90%, and conclusive diagnosis in 92% of patients.

- VQ scan: sens. 49%, spec. 74%, and conclusive diagnosis in 72% of patients.

Blachere et al.: 179 patients having both CT angiogram and VQ scan irrespective of chest x-ray.

- CT scan: sens. 94%, spec. 94%, and conclusive diagnosis in 97.2% of patients.

- VQ scan: sens. 81%, spec. 74%, and conclusive diagnosis in conclusive diagnosis in 51% of patients.

Only 17 of 179 patients (9%) had normal radiographs:
NORMAL CHEST XRAY AND VQ SCAN

Gottschalk A et al. *: Among 115 patients, VQ scan yielded definite diagnosis (PE present or absent) in 83%.

Goodman LR **: definite VQ scan increased from 48% to 70% of subjects when triaging based on Chest Xray is used.

VQ scan is the initial modality of choice in the setting of normal chest Xray and no history of significant cardiopulmonary disease.

THE NEW APPROACH

DISADVANTAGES OF PE IMAGING TESTS

• A VENTILATION/PERFUSION LUNG SCAN
  It is usually non-diagnostic (intermediate probability) when the chest x-ray is abnormal

• A CT ANGIOGRAM
  It may miss (multiple) small peripheral emboli, which are usually associated with a normal chest x-ray
The New Approach

When, in the presence of predisposing factors, clinical and laboratory evidence for PE develops

ORDER A CHEST X-RAY

• If it turns out to be essentially Normal order a VENTILATION/PERFUSION LUNG SCAN

• If it shows significant infiltrates or effusions order a CT ANGIOGRAM
VENTILATION/PERFUSION LUNG SCAN

NORMAL

Ventilation

Perfusion

1. POST 1  2. LPO 2  3. RPO 3  4. RAO 4  5. ANT LV 5  6. LAO 6
VENTILATION/PERFUSION LUNG SCAN

MISS-MATCH - CHEST X-RAY NL

Mismatches = High Probability for Pulmonary Thromboembolism
PATIENT WITH SUSPICION OF PE
VENTILATION/PERFUSION LUNG SCAN

Mismatch = High Probability for Pulmonary Thromboembolism
VENTILATION/PERFUSION LUNG SCAN

A Negative for PE study assures good prognosis without the need for anticoagulation therapy.

A High Probability for PE study underlines the need for anticoagulation therapy.
INITIAL INVESTIGATION ALGORITHM FOR PULMONARY EMBOLISM

Chest x-ray

- Normal
  - VQ scan
    - PE excluded: Don’t treat
    - PE diagnosed: Treat
    - Indeterminate: CT angio or leg U/s
- Abnormal
  - CT angio
    - PE excluded: Don’t treat
    - PE diagnosed: Treat
    - Indeterminate
PARTIAL AND COMPLETE RESOLUTION RATES OF PE IN THREE AGE CATEGORIES

Age <40

Age 40-60

Age >60

- Orange: No resolution
- Cyan: Partial resolution
- Red: Complete resolution
OUTCOME FOR PATIENTS WITH HIGH PROBABILITY VQ SCANS

Barritt DW et al.

Randomized controlled trial in patients with massive PE.

Patients randomized into two group:

anticoagulants versus no anticoagulants.

Mortality: 26% in untreated group and 6% in treated group.

Study was stopped after 35 patients were included.

OUTCOME FOR PATIENTS WITH INTERMEDIATE PROBABILITY VQ SCANS

116 patients not anticoagulated.

Follow up lower limb Doppler U/S and VQ scan performed in all patients.

Results: 22 deaths (18%) reported, none associated with PE.

OUTCOME FOR PATIENTS WITH LOW PROBABILITY VQ SCANS (1)

Patients with low probability scans with inadequate cardiorespiratory reserve (n=77):

- pulmonary edema
- right-ventricular failure
- hypotension
- syncope
- acute tachyarrhythmia
- abnormal spirometry (FEV1 < 1.0L or VC < 1.5 L)
- abnormal ABGs (PO2 < 50mmHg or PCO2, >45mmHg)

Patients with non-diagnostic scans and good cardiorespiratory reserve (n=711)

OUTCOME FOR PATIENTS WITH LOW PROBABILITY VQ SCANS (2)

Mortality Rate

Mortality

LOW PROBABILITY SCAN

Low probability VQ

- Presence of cardiopulmonary disease: Admit
- Absence of cardiopulmonary disease: Discharge home
Figure 2. Regulation of Blood Coagulation and Fibrinolysis.
Coagulation is initiated by a tissue factor (TF)–factor VIIa complex that can activate factor IX or factor X. At high tissue factor concentrations, factor X is activated primarily by the TF-VIIa complex, whereas at low tissue factor concentrations the contribution of the factor IXa–factor VIIa complex to the activation of factor X becomes more pronounced. Tissue factor–dependent coagulation is rapidly inhibited by tissue factor–pathway inhibitor (TFPI). Coagulation is maintained through the activation by thrombin of factor XI. Through the intrinsic tenase complex (factors IXa and VIIIa) and the prothrombinase complex (factors Xa and Va), the additional thrombin required to down-regulate fibrinolysis is generated by the activation of thrombin-activatable fibrinolysis inhibitor (TAFI). Activated TAFI down-regulates fibrinolysis by removing from partially degraded fibrin C-terminal lysine residues that are involved in the binding and activation of plasminogen. The coagulation system is regulated by the protein C pathway. Thrombin activates protein C in the presence of thrombomodulin. Together with protein S, activated protein C (APC) is capable of inactivating factors Va and VIIIa, which results in a down-regulation of thrombin generation and consequently in an up-regulation of the fibrinolytic system. The activity of thrombin is controlled by the inhibitor antithrombin. The solid arrows indicate activation and the broken arrows inhibition. To improve the clarity of the figure, most zymogens and procoagulant surfaces are not depicted. Modified from Bouma et al.66 with the permission of the publisher.