American College of Radiology Appropriateness Criteria ®

Acute Chest Pain: Suspected Pulmonary Embolism

Ji Buethe, MD (PGY4); John Nazarian, MD (PGY5)
University Hospitals Case Medical Center
Case Western Reserve University
Department of Radiology
Evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition.

By employing these guidelines, providers enhance quality of care and contribute to the most efficacious use of radiology.

The guidelines are developed by expert panels in diagnostic imaging, interventional radiology, and radiation oncology.

Each panel includes leaders in radiology and other specialties. There are 201 topics with 983 variants in the May 2014 version.
ACR Value-Based Practice Quality Improvement (PQI) Project

- Seeks to improve the appropriate selection of imaging exams by:
  - Engaging radiologists in research about the patterns of imaging exams performed by their practice
  - Empowering radiologists with educational strategies for working with referring physicians to improve their selection of imaging exams, and
  - Evaluating and reporting on the relative effectiveness of educational strategies.
Utilize evidence-based ACR AC to evaluate the rate of appropriate versus inappropriate exams being ordered for a specific imaging study before and after educational interventions with referring clinicians.
Recording baseline data: phase 1
- Select a study for which they experience frequent inappropriate referrals from either referring physicians and measure the prevalence of this occurrence over a certain period of time. The level of exam appropriateness is determined by the ACR AC (discussed later).

Action plan for improvement: phase 2
- Intervention plan to educate the referring physicians re ACR AC.

Reassess and document improvement: phase 3
- Repeat the process described for Phase 1. The centrally collected data stored by the ACR will allow comparison of individual practices to peer data.
Over 290,000 cases of fatal pulmonary embolism (PE) and 230,000 cases of nonfatal PE are estimated to occur in the US each year.

- Many cases may not be diagnosed due to the nonspecific nature of presenting symptoms.

Approximately 80% of PE cases are associated with deep venous thrombosis (DVT).
Goals of the diagnostic workup include:
- Reaching acceptable level of diagnostic certainty to warrant anticoagulation
- Excluding other reasons for the patient’s symptoms

Bayesian approach
- Pre-test probability => modified by diagnostic tests => post-test probability
Validated clinical decision trees: Wells criteria

- **Wells score:**
  - Clinically suspected DVT: 3.0 points
  - Alternative diagnosis less likely than PE: 3.0 points
  - Tachycardia (HR > 100): 1.5 points
  - Immobilization >3 days/surgery in previous 4 weeks: 1.5 points
  - History of DVT or PE: 1.5 points
  - Hemoptyysis: 1.0 points
  - Malignancy: 1.0 points

- **Traditional interpretation:**
  - >6.0: High (probability 59%)
  - 2.0-6.0: Moderate (29%)
  - <2.0: Low (15%)
## Modified Wells Criteria

- Clinical signs or symptoms of DVT: 3.0 points
- Alternative diagnosis less likely than PE: 3.0 points
- Tachycardia (HR > 100): 1.5 points
- Previous history of DVT or PE: 1.5 points
- Hemoptysis: 1.0 points
- Active cancer within the last 6 months: 1.0 points

<table>
<thead>
<tr>
<th>Score</th>
<th>Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;6.0</td>
<td>High risk for PE (probability 59%)</td>
</tr>
<tr>
<td>2.0-6.0</td>
<td>Moderate (29%)</td>
</tr>
<tr>
<td>&lt;2.0</td>
<td>Low (15%)</td>
</tr>
</tbody>
</table>

- Simplified Wells Criteria: 
  - ≤ 4 points ➔ PE unlikely
  - ≥ 4 points ➔ PE unlikely
D-dimer assay

- Limited value in the following:
  - Patients with a significant thrombotic process
    - Pregnant, postoperative, trauma patients.
  - Patients determined to be at high risk of PE by validated clinical criteria (see previous slide)

- In all other settings, a negative D-dimer test effectively excludes PE or DVT
Chest radiography

- Important initial examination in evaluation of suspected PE
- Can eliminate the need for additional studies by revealing an alternate reason for acute symptoms (e.g. pneumonia, pleural effusion, acute heart failure)
- Normal chest x-ray does NOT exclude PE, and no x-ray findings are sufficient to confirm PE
- Recent chest x-ray (<24 hours) is required for accurate interpretation of ventilation/perfusion studies
Current standard of care; highly sensitive and specific for diagnosis

Fewer “nondiagnostic” examinations compared with ventilation/perfusion scans

Can identify signs of right ventricular dysfunction

Has nearly completely replaced conventional catheter-directed angiography
  - Now reserved for situations where thrombectomy or thrombolysis may be indicated
42 year old with shortness of breath

CT pulmonary angiography
Other imaging modalities

- Ventilation/perfusion (V/Q) imaging
  - Previous standard of care; good overall diagnostic accuracy
  - In our institution, used in cases of contrast intolerance or renal failure (GFR <30)

- Ultrasound
  - Presence of DVT does not indicate presence of PE but may increase its likelihood (and a negative study significantly decreases its likelihood)
  - Finding a DVT allows identical treatment plan, so no further workup for PE is necessary
  - For more detailed discussion, refer to ACR-AC on “Suspected Lower Extremity Deep Vein Thrombosis”

- Magnetic resonance angiography (MRA)/MR perfusion imaging
  - Limited role, performed at some institutions
Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure.

Relative radiation level (RRL) are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure.

Reimbursement and billing
## Clinical Condition:
Acute Chest Pain — Suspected Pulmonary Embolism

### Variant 1:
Adult.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray chest</td>
<td>9</td>
<td>To exclude other causes of acute chest pain. Complementary to other examinations.</td>
<td>4</td>
</tr>
<tr>
<td>CTA chest with contrast</td>
<td>9</td>
<td>Current standard of care for detecting PE.</td>
<td>4</td>
</tr>
<tr>
<td>Tc-99m V/Q scan lung</td>
<td>8</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>US lower extremity with Doppler</td>
<td>7</td>
<td>If chest x-ray is negative and index of suspicion is high.</td>
<td>0</td>
</tr>
<tr>
<td>CTA chest with contrast with CT venography lower extremities</td>
<td>6</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Arteriography pulmonary with right heart catheterization</td>
<td>5</td>
<td>If suspicion is high and CTA is inconclusive, or if intervention is needed.</td>
<td>4</td>
</tr>
<tr>
<td>MRA pulmonary arteries without and with contrast</td>
<td>4</td>
<td>If patient is unable to receive iodinated contrast, may be alternative to V/Q scan. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>O</td>
</tr>
<tr>
<td>MRA pulmonary arteries without contrast</td>
<td>3</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>US echocardiography transesophageal</td>
<td>2</td>
<td>Limited experience. Has been used for central pulmonary emboli.</td>
<td>O</td>
</tr>
<tr>
<td>US echocardiography transthoracic resting</td>
<td>2</td>
<td>To assess for RV strain or failure in the presence of major pulmonary embolism.</td>
<td>O</td>
</tr>
</tbody>
</table>

### Relative Radiation Level Designations

<table>
<thead>
<tr>
<th>Relative Radiation Level*</th>
<th>Adult Effective Dose Estimate Range</th>
<th>Pediatric Effective Dose Estimate Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>0 mSv</td>
<td>0 mSv</td>
</tr>
<tr>
<td>🔗</td>
<td>&lt;0.1 mSv</td>
<td>&lt;0.03 mSv</td>
</tr>
<tr>
<td>.SEVERITY</td>
<td>0.1-1 mSv</td>
<td>0.03-0.3 mSv</td>
</tr>
<tr>
<td>.SEVERITY</td>
<td>1.0-10 mSv</td>
<td>0.3-3 mSv</td>
</tr>
<tr>
<td>.SEVERITY</td>
<td>10-30 mSv</td>
<td>3.0-10 mSv</td>
</tr>
<tr>
<td>.SEVERITY</td>
<td>30-100 mSv</td>
<td>10-30 mSv</td>
</tr>
</tbody>
</table>

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies”. 

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

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*Relative Radiation Level
Suspected PE in pregnant patients

- As with non-pregnant patients, a chest x-ray should be performed first to exclude other causes of symptoms.

- Both CTA and V/Q scans are considered “usually appropriate” for evaluation; this is considered a judgment call based on “local equipment and expertise as well as patient factors.”
  - V/Q scan can be performed with perfusion-only images.
  - If perfusion images are normal, no ventilation images are required.
Summary of recommendations

- Acute chest pain – suspected PE
  - Chest x-ray: appropriate initial exam (“usually appropriate”) to be performed complementarily with other modalities to exclude other causes of symptoms
  - CTA chest: current standard of care (“usually appropriate”)
  - Nuclear V/Q scan is an acceptable substitute in cases where CT cannot be performed (“usually appropriate”)
  - Because of the association between PE and DVT, ultrasound (“usually appropriate”) can also be used in a troubleshooting role

- Suspected PE in a pregnant patient
  - Recommendations are similar; the choice of CTA or V/Q scan is made at an institutional level
    - If V/Q scan is performed, perfusion-only images can be obtained
    - If normal, the study can be completed
  - At our institution, CTA (PE protocol) is considered safe and acceptable for pregnant patients – Patients need radiologist consultation and sign a consent.
ACR AC for Suspected PE – Decision tree

1. Determine if “PE unlikely” or “PE likely”
   - PE unlikely
     - D-dimer assay
       - <500 ng/mL → PE excluded
       - >500 ng/mL
   - PE likely
     - Spiral CT pulmonary angiogram (CT-PA)
       - Negative → PE excluded
       - Positive → PE confirmed
Clinical history/signs/symptoms that qualify for 7-9 (usually appropriate) rating scale for CTA PE per ACR AC:

1. Previous DVT/PE
2. Immobilization (>= 3 days) or surgery/fracture in the previous 4 weeks
3. Clinical symptoms of DVT (leg swelling, pain with palpation)
4. Heart rate > 100
5. Hemoptysis
6. Active malignancy
7. If none of the above (1-6) and D-dimers > 500 ng/ml

If none of the above (1-6) and D-dimers < 500 ng/ml CTA PE = 2 (inappropriate)
ACR AC for Suspected PE

1. Pulmonary embolism likely, **high/moderate clinical probability** (Modified Wells criteria score >4.0 or revised Geneva score >2) CT angiography, chest, w iv contrast = **9 points** (usually appropriate)

2. Pulmonary embolism unlikely, **low clinical probability** (modified Wells criteria score ≤4.0 or revised Geneva score ≤2) CT angiography, chest, w iv contrast = **3 points** (usually NOT appropriate)

3. Pulmonary embolism unlikely, **low clinical probability** (modified Wells criteria score ≤4.0 or revised Geneva score ≤2), **positive/elevated d-dimer level** (>500 ng/mL) CT angiography, chest, w iv contrast = **9 points** (usually appropriate)

4. Pulmonary embolism unlikely, **low clinical probability** (modified Wells criteria score ≤4.0 or revised Geneva score ≤2), **negative d-dimer level** (<500 ng/mL) CT angiography, chest, w iv contrast = **1 point** (usually NOT appropriate)
References


- Please refer to the most updated version at http://www.acr.org/Quality--Safety/Appropriateness--Criteria
Thank you!

Contact information: ji.buethe@uhhospitals.org