GOALS AND MEASURES

This CPM was developed by Intermountain clinical experts to outline appropriate use criteria (AUC) for advanced imaging for suspected pulmonary embolism (PE). These guidelines, together with those for other priority clinical areas, will improve the quality of care provided to patients by:

- Increasing adherence to evidence-based AUC for the use of advanced imaging
- Reducing imaging tests that do not conform to AUC or for which there are no guidelines
- Decreasing system-wide spending on unnecessary advanced imaging services
- Reducing risk associated with unwarranted patient exposure to radiation and/or contrast media
- Documenting the incidence of a significant positive on advanced imaging tests and aligning with downstream care
OVERVIEW: PROVEN IMAGING APPROPRIATE USE CRITERIA CONTENT

Intermountain Proven Imaging Appropriate Use Criteria (AUC) support clinicians in providing evidence-based care to the patients they serve. Although appropriate use of Proven Imaging fulfills compliance requirements under PAMA, patients only fully benefit from their use as they are deployed within the framework of a locally driven quality improvement program. To learn more about Intermountain’s process for developing and maintaining AUC, visit: https://intermountainhealthcare.org/services/imaging-services/proven-imaging/.

The care process model approach

Designed as Care Process Models (CPMs), the Proven Imaging AUC content is a blueprint that logically guides the delivery of evidence-based care via an algorithmic visual presentation (see pages 5 through 8). Although these Proven Imaging CPMs specifically focus on the appropriate use of advanced imaging, they can be viewed as portions of broader CPMs that guide not only diagnostic but therapeutic interventions for a specific disease or condition.

Ideally, Proven Imaging CPMs are engaged early in the patient encounter and guide the various considerations that lead to the ultimate decision regarding ordering of an imaging study. For providers who engage at the point of ordering, point-of-order checklists are also included in the CPMs (beginning on page 9). These checklist-based guidelines are logically equivalent to the algorithms from which they are derived.

Knowing that local factors will invariably impact decisions about selecting the most appropriate exam, Proven Imaging CPMs specify the generally preferred exam but also provide alternative choices that may be appropriate in certain clinical settings.

Relative imaging cost and radiation risk rankings

To further aid providers, each algorithm includes a ranking of relative costs and radiation risk for each advanced imaging test recommended. The cost scale is derived using global non-facility RVUs published by CMS as a surrogate for cost. The radiation risk is derived from data published in 2010 by the Health Physics Society.

Evidentiary review and ranking

Intermountain used the following two conceptual frameworks for evidentiary review of relevant literature:

1. The 2011 revision of the Oxford Centre for Evidence-Based Medicine (OCEMB) 2011 Levels of Evidence standard. This standard includes categorical levelling grades relevant to diagnostic studies and rates individual sources of evidence (published papers or other research data) on a five-point scale.

2. The extensively used Fryback and Thornbury conceptual framework, which uses six levels for assessing the efficacy of diagnostic imaging.

Each algorithmic presentation provides both rankings for the decision node (pairing of AUC and recommended / alternative tests).

Using the algorithms and checklists

Under “Care Pathway” on page 3, there is an annotated algorithmic sample for a typical clinical scenario found in this CPM. Under “Point-of-Order Checklist” on page 4, there is an annotated sample of a typical point-of-order checklist for an imaging procedure recommended within the above sample algorithm.

Abbreviations used in this CPM

Abbreviations used in this CPM

<table>
<thead>
<tr>
<th>AUC</th>
<th>appropriate use criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPG</td>
<td>clinical practice guideline</td>
</tr>
<tr>
<td>CPM</td>
<td>care process model</td>
</tr>
<tr>
<td>CT</td>
<td>computed tomography</td>
</tr>
<tr>
<td>CTPA</td>
<td>CT pulmonary angiogram</td>
</tr>
<tr>
<td>CUS</td>
<td>compression ultrasonography</td>
</tr>
<tr>
<td>CXR</td>
<td>chest x-ray (radiograph)</td>
</tr>
<tr>
<td>DVT</td>
<td>deep vein thrombosis</td>
</tr>
<tr>
<td>eGFR</td>
<td>estimated glomerular filtration rate</td>
</tr>
<tr>
<td>MRI</td>
<td>magnetic resonance imaging</td>
</tr>
<tr>
<td>PCP</td>
<td>primary care provider</td>
</tr>
<tr>
<td>PE</td>
<td>pulmonary embolism</td>
</tr>
<tr>
<td>PERC</td>
<td>pulmonary embolism rule-out criteria</td>
</tr>
<tr>
<td>PET</td>
<td>positron emission tomography</td>
</tr>
<tr>
<td>RGS</td>
<td>revised Geneva score</td>
</tr>
<tr>
<td>V/Q</td>
<td>ventilation-perfusion</td>
</tr>
<tr>
<td>VTE</td>
<td>venous thromboembolism</td>
</tr>
</tbody>
</table>
**Suspected Pulmonary Embolism (PE)**

**Care pathways**

For each clinical scenario (e.g., suspected pulmonary embolism in non-pregnant patients), there is an algorithmic presentation of the care pathway context for the imaging decisions made. This pathway contains not only the appropriate use criteria (AUC) and evidence-based advanced imaging recommendations, but also what constitutes significant positive imaging results and downstream care recommendations. Note the elements of this presentation below and key information provided in each test recommendation box as shown at right. There is a legend at the bottom of each care pathway page.

The decision node box encompasses recommended advanced imaging based on the presence of evidence-based appropriate use criteria (AUC) or expert consensus (where evidence does not exist).

**AUC met? (Any of the 3 following conditions)**
- PE highly likely
  - PERC > 0
  - RGS ≥ 11
- PE somewhat likely
  - PERC > 0
  - RGS 0–10
  - Age-adjusted d-dimer positive
- PE possible
  - PERC > 0
  - RGS 0–10
  - D-dimer likely to be unreliable given comorbidities

**Emergency referral** if patient unstable

**Imaging: primary recommendation**
- CTPA
  - V1
  - $\$R4$

**Imaging: alternative recommendation**
- V/Q Scan
  - I
  - $\$R3$

**DO NOT TREAT***

- CONSIDER alternative diagnosis

**Significant positive* result?**
- PE present

**TREAT for PE per system-wide protocol**

**Significant positive** result?
- High probability for PE

**DO NOT TREAT**

- CONSIDER alternative diagnosis

**Downstream care recommendations** are general guidelines and are subject to the discretion of individual healthcare providers and the providers’ system protocols.

**EMERGENCY REFERRAL** if patient unstable

The Arabic number in the green box indicates an evidence ranking derived from the OCEBM scale. For this scale, the lower the number, the stronger the evidence ranking.

The Roman numeral in the orange box indicates an evidence ranking derived from the Fryback & Thornbury scale. For this scale, the higher the number, the stronger the evidence ranking.

Cost rankings are indicated based on a range developed from the CMS Global Relative Value Units (RVUs) as follows:

- $ = 0–5 RVUs
- $$$ = 10–15 RVUs
- $$$$ = 15+ RVUs

Radiation risk rankings use the scale developed by the American College of Radiology. This rating framework offers the following six levels for adult effective dose range risk:

- R0 = 0 mSv
- R1 = < 1 mSv
- R2 = 0.1–1 mSv
- R3 = 1–10 mSv
- R4 = 10–30 mSv
- R5 = 30–100 mSv

This red flag signifies an urgent or emergency situation (sometimes this red flag indicates a scenario that may require bypassing the AUC logic).

This symbol indicates an Intermountain internal measure. Intermountain measures incidence of significant positive results on advanced imaging tests.

An alternative imaging recommendation has been included for when a test is contraindicated or otherwise clinically appropriate.

**DECISION NODE #1**

**Suspected PE in non-pregnant patients**
Point-of-order checklists
For each advanced imaging test (e.g., CTPA and V/Q scan), there is a checklist that compiles all of the appropriate use criteria from each clinical scenario (shown in the care pathways) for that test. These are presented in a checklist format for the provider to select the appropriate scenario AND the criteria that apply to the patient’s situation.

### TABLE 1. CTPA appropriate use indications

<table>
<thead>
<tr>
<th>(PRIMARY recommendation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Suspected PE in NON-PREGNANT patients (IF ANY of these 3 situations):</td>
</tr>
<tr>
<td>☐ PE highly likely</td>
</tr>
<tr>
<td>PERC &gt; 0</td>
</tr>
<tr>
<td>AND</td>
</tr>
<tr>
<td>RGS ≥ 11</td>
</tr>
<tr>
<td>☐ PE somewhat likely</td>
</tr>
<tr>
<td>PERC &gt; 0</td>
</tr>
<tr>
<td>AND</td>
</tr>
<tr>
<td>RGS 0 – 10</td>
</tr>
<tr>
<td>AND</td>
</tr>
<tr>
<td>Age-adjusted d-dimer positive</td>
</tr>
<tr>
<td>☐ PE possible</td>
</tr>
<tr>
<td>PERC &gt; 0</td>
</tr>
<tr>
<td>AND</td>
</tr>
<tr>
<td>RGS 0 – 10</td>
</tr>
<tr>
<td>AND</td>
</tr>
<tr>
<td>D-dimer likely to be unreliable given comorbidities</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(ALTERNATIVE recommendation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Suspected PE in PREGNANT patients (ALL criteria must be met for either of the following 2 sets of conditions)</td>
</tr>
<tr>
<td>☐ Abnormal CXR</td>
</tr>
<tr>
<td>☐ No DVT symptoms</td>
</tr>
<tr>
<td>☐ No contrast allergy or eGFR ≥ 30</td>
</tr>
<tr>
<td>OR</td>
</tr>
<tr>
<td>☐ Non-diagnostic V/Q Scan</td>
</tr>
<tr>
<td>☐ No contrast allergy or eGFR ≥ 30</td>
</tr>
</tbody>
</table>

Tables included on page 9 indicate when the test is a primary recommendation or an alternate recommendation.
PROVEN IMAGING FOR Suspected Pulmonary Embolism (PE)

SUSPECTED PULMONARY EMBOLISM (PE) CARE PATHWAY ALGORITHMS

LEGEND

Clinical Scenario
Urgent or Emergency Situation
OCEBM Level of Evidence
Fryback & Thornbury Level of Evidence
Intermountain Measure

RO (0 mSv) $ (0–5 RVUs)
R3 (1–10 mSv) $ (5–10 RVUs)
R4 (10–30 mSv) $ (10–15 RVUs)
$ $ $ (15+ RVUs)

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DECISION NODE #1 KEY EVIDENCE


(For a list of references for all decision nodes, see the complete bibliography on pages 11 through 13)
**PROVEN IMAGING FOR**  
**Suspected Pulmonary Embolism (PE)**

---

**DECISION NODE #2A**

**Suspected PE in pregnant patients**

- **AUC met? (IF ALL)**
  - Normal CXR
  - No DVT symptoms
  - Normal CXR
  - No contrast allergy AND eGFR ≥ 30

OR alternative imaging (IF ALL)

- V/Q Scan*
  - 2
  - $5
  - R3

**EMERGENCY REFERRAL** if patient unstable

---

**DECISION NODE #2B**

- **AUC met? (IF ALL)**
  - Abnormal CXR
  - No DVT symptoms
  - No contrast allergy AND eGFR ≥ 30
  - OR (IF ALL)
  - Normal CXR
  - Non-diagnostic V/Q Scan
  - No contrast allergy AND eGFR ≥ 30

**EMERGENCY REFERRAL** if patient unstable

---

**Imaging: alternative recommendation**

- **CTPA**
  - 2
  - $5
  - R4

---

**PERFORM bilateral CUS.**

**TREAT for PE per Suspected PE in Pregnancy CPM or other system-wide protocol**

---

See abbreviations on page 2.
**PROVEN IMAGING FOR Suspected Pulmonary Embolism (PE)**

**DECISION NODE #2A & #2B KEY EVIDENCE**


(For a list of references for all decision nodes, see the complete bibliography on pages 11 through 13)
TABLE 1. CTPA appropriate use indications

(PRIMARY recommendation)

☐ Suspected PE in NON-PREGNANT patients (IF ANY of these 3 situations):
  ☐ PE highly likely
    PERC > 0
    AND
    RGS ≥ 11
  ☐ PE somewhat likely
    PERC > 0
    AND
    RGS 0 – 10
    AND
    Age-adjusted d-dimer positive
  ☐ PE possible
    PERC > 0
    AND
    RGS 0 – 10
    AND
    D-dimer likely to be unreliable given comorbidities

(ALTERNATIVE recommendation)

☐ Suspected PE in PREGNANT patients (ALL criteria must be met for either of the following 2 sets of conditions)
  ☐ Normal CXR
  ☐ No DVT symptoms
  OR
  ☐ Abnormal CXR
  ☐ No DVT symptoms
  ☐ Contrast allergy or eGFR < 30

See abbreviations on page 2.

TABLE 2. V/Q Scan appropriate use indications

(PRIMARY recommendation)

☐ Suspected PE in PREGNANT patients (ALL criteria must be met for either of the following 2 sets of conditions)
  ☐ Normal CXR
  ☐ No DVT symptoms
  OR
  ☐ Abnormal CXR
  ☐ No DVT symptoms
  ☐ Contrast allergy or eGFR < 30

(ALTERNATIVE recommendation)

☐ Suspected PE in NON-PREGNANT patients
  ☐ Contrast allergy or eGFR < 30
  AND ANY of these 3 situations:
  ☐ PE highly likely
    PERC > 0
    AND
    RGS ≥ 11
  ☐ PE somewhat likely
    PERC > 0
    AND
    RGS 0 – 10
    AND
    Age-adjusted d-dimer positive
  ☐ PE possible
    PERC > 0
    AND
    RGS 0 – 10
    AND
    D-dimer likely to be unreliable given comorbidities

See abbreviations on page 2.
Intermountain provides educational materials designed to support providers in their efforts to care for, educate, and engage patients and their families.

**Intermountain’s patient education materials** complement and reinforce clinical team interventions by providing a means for patients to reflect and learn in another mode and at their own pace.

**Intermountain’s Care Process Models (CPMs)** outline evidence-based guidelines for patient care. In addition to the suite of Proven Imaging CPMs, Intermountain provides topical CPMs that have been developed by expert clinical teams. They can be accessed by navigating to [intermountainphysician.org](http://intermountainphysician.org) and selecting Care Process Models in the Tools and Resources drop down menu.

To access Intermountain’s Proven Imaging CPMs and supporting materials, visit: [https://intermountainhealthcare.org/services/imaging-services/proven-imaging/](https://intermountainhealthcare.org/services/imaging-services/proven-imaging/).

**Fact sheets:**
- Computed Tomography (CT) Scan
- Radiation Exposure in Medical Tests
- Deep Vein Thrombosis and Pulmonary Embolism
- Deep Vein Thrombosis: Prevention During and After Pregnancy

**Related Care Process Models (CPMs):**
- **Diagnosis and Management of Venous Thromboembolism CPM**
- **Evaluation of Suspected Pulmonary Embolism in Pregnancy CPM**
- **Imaging Radiation Exposure CPM**
PROVEN IMAGING FOR Suspected Pulmonary Embolism (PE)

BIBLIOGRAPHY

NODE #1


NODES #2A & #2B


PROVEN IMAGING FOR Suspected Pulmonary Embolism (PE)

REFERENCES (from pages 1 through 3)


This CPM presents a model of best care based on the best available scientific evidence at the time of publication. It is not a prescription for every physician or every patient, nor does it replace clinical judgment. All statements, protocols, and recommendations herein are viewed as transitory and iterative. Although physicians are encouraged to follow the CPM to help focus on and measure quality, deviations are a means for discovering improvements in patient care and expanding the knowledge base. Send feedback to ProvenImaging@imail.org.

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Intermountain Healthcare developed and endorses the Appropriate Use Criteria contained in this Care Process Model as a Provider-Led Entity qualified by the Centers for Medicare and Medicaid Services. Patient and Provider Publications CPM3008 - 12/18