Through its Intermountain Imaging Criteria Project, Intermountain Healthcare has developed a suite of standardized care process models (CPMs) for the use of advanced imaging procedures in eight priority clinical areas. These evidence-based guidelines are intended to be widely implemented in order to improve patient safety, improve outcomes, and reduce unnecessary medical spending for the Medicare population and the U.S. health system overall.

**Why Focus ON INTERMOUNTAIN IMAGING CRITERIA?**

Advanced imaging procedures, including MRI, CT, PET, and nuclear medicine, facilitate rapid and accurate detection and/or diagnosis of disease. The volume of advanced imaging procedures prescribed to patients in the U.S. increased three- to four-fold from 1996–2010 as the technologies became widely available. The inflating costs of advanced imaging outstripped that of any other medical service. These inflating costs resulted in up to $20 – 30 billion in unnecessary advanced imaging spending each year.

- **High cost.** Although the spending growth in advanced imaging dropped off after the early 2000s, 2014 costs to Medicare Part B for advanced imaging exceeded $2.4 billion for common conditions alone.
- **Limited effectiveness.** Multiple studies suggest that up to a third of advanced imaging procedures fail to contribute to diagnosis or are clinically inappropriate.
- **Patient safety.** Advanced diagnostic imaging often exposes the patient to ionizing radiation and/or contrast media, posing additional medical risks that must be weighed against the potential benefits of the imaging procedure.
- **Overdiagnosis and overtreatment.** There is a risk of overdiagnosis and subsequent overtreatment that carries associated risks (e.g., drug reactions or unnecessary surgical interventions) if advanced imaging is performed in patients with low pretest probability. The Intermountain Imaging Criteria approach seeks to avoid these risks.

**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: INTERMOUNTAIN IMAGING CRITERIA APPROPRIATE USE CRITERIA CONTENT

Intermountain Imaging Criteria appropriate use criteria (AUC) support clinicians in providing evidence-based care to the patients they serve. Although appropriate use of Intermountain Imaging Criteria 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/intermountain-imaging-criteria/.

The care process model approach

Designed as Care Process Models (CPMs), the Intermountain Imaging Criteria 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 Intermountain Imaging Criteria 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, Intermountain Imaging Criteria 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, Intermountain Imaging Criteria 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 relative-value units (RVUs) published by the Centers for Medicare and Medicaid Services (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 (OCEBM) 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 pathways” 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

- AUC = appropriate use criteria
- CMS = Centers for Medicare and Medicaid Services
- CPG = clinical practice guideline
- CPM = care process model
- CT = computed tomography
- CTPA = CT pulmonary angiogram
- CUS = compression ultrasonography
- CXR = chest x-ray (radiograph)
- DVT = deep vein thrombosis
- eGFR = estimated glomerular filtration rate
- MRI = magnetic resonance imaging
- PCP = primary care provider
- PE = pulmonary embolism
- PERC = pulmonary embolism rule-out criteria
- PET = positron emission tomography
- RGS = revised Geneva score
- RVU = relative-value units
- V/Q = ventilation-perfusion
- VTE = venous thromboembolism
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.

Algorithms are grouped as indicated on page 2.

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).

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. This rating framework offers the following six levels for adult effective dose range risk:
- $0 = 0 – 5$ mSv
- $S = 5 – 10$ mSv
- $SS = 10 – 15$ mSv
- $SSS = 15 – 20$ mSv
- $SSSS = 20 – 30$ mSv
- $SSSSS = 30 – 100$ mSv

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 a common clinical scenario.

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

Tables included on page 9 indicate when the test is a primary recommendation or an alternate recommendation.

<table>
<thead>
<tr>
<th>TABLE 1. CTPA appropriate use indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>(PRIMARY recommendation)</td>
</tr>
<tr>
<td>☐ Suspected PE in NON-PREGNANT patients (IF EITHER of these 2 situations):</td>
</tr>
<tr>
<td>☐ PE highly likely (PERC &gt; 0 AND RGS ≥ 11)</td>
</tr>
<tr>
<td>OR</td>
</tr>
<tr>
<td>(ALTERNATIVE recommendation)</td>
</tr>
<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 AND eGFR ≥ 30</td>
</tr>
<tr>
<td>OR</td>
</tr>
<tr>
<td>☐ No contrast allergy AND eGFR ≥ 30</td>
</tr>
</tbody>
</table>
### Suspected Pulmonary Embolism (PE) Care Pathway Algorithms

**Suspected PE in non-pregnant patients**

* A negative or positive result of a qualitative d-dimer test should be used in the same way as an age-adjusted quantitative d-dimer. Age-adjustment of qualitative d-dimers is not possible. If d-dimer failed to result or is likely to be unreliable due to comorbidities, imaging should be performed.

1. Use imaging alternative if contrast allergy or eGFR < 30.
2. Additional testing or consultation may be pursued if persistent concern for PE, particularly in patients with high pretest probability.
3. If CTPA non-diagnostic, PERFORM V/Q Scan or PERFORM bilateral CUS, and TREAT if DVT present. If CUS negative, CONSIDER additional testing or thrombosis consult.
4. If V/Q Scan indeterminate or non-diagnostic, PERFORM CTPA if not contraindicated. If CTPA contraindicated, PERFORM bilateral CUS and TREAT if DVT present. If CUS negative, CONSIDER additional testing or thrombosis consult.

**DECISION NODE #1**

**AUC met? (EITHER of the 2 following conditions)**

- PE highly likely (PERC > 0 AND RGS ≥ 11) OR
- PE possible (PERC > 0 AND RGS 0–10 AND d-dimer positive* (≥ 500, or age x 10 if ≥ 50 years))

**EMERGENCY REFERRAL if patient is unstable**

**Imaging: primary recommendation**

- CTPA
  - 1
  - VI
  - $$$ R4

**Imaging: alternative recommendation**

- V/Q Scan
  - 1
  - II
  - $$$ R3

**Significant positive result?**

- Yes
  - TREAT for PE per system-wide protocol

- No
  - DO NOT TREAT

**DO NOT TREAT. (PE is excluded w/o imaging when EITHER PERC = 0 OR PERC > 0 AND RGS < 11 AND d-dimer < 500) CONSIDER further testing AND alternative diagnosis**

---

**LEGEND**

- **Clinical Scenario**
- **Urgent or Emergency Situation**
- **OCEBM Level of Evidence**
- **Fryback & Thornbury Level of Evidence**
- **Intermountain Measure**
- **RO (0 mSv)**
- **R 3 (1–10 mSv)**
- **R 4 (10–30 mSv)**
- **$ (0–5 RVUs)**
- **$$ (5–10 RVUs)**
- **$$ $ (10–15 RVUs)**
- **$$ $$ $ (15+ RVUs)**
DEcision node #1 key evidence


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

**DECISION NODE #2A**

**Suspected PE in pregnant patients**

- **AUC met? (IF ALL)**
  - Normal CXR
  - No DVT symptoms
  - No contrast allergy
  - eGFR $\geq 30$

  - **yes**
    - Imaging: primary recommendation
      - V/Q Scan*
      - 2
      - $\$5$
      - R3

  - **no**
    - EMERGENCY REFERRAL if patient unstable

**RESULT?**

- *(+) Result?* TREAT for PE per Venous Thromboembolism CPM or other system-wide protocol

- *(-) Result?* REFER to obstetrics
  - CONSIDER alternative diagnosis

---

**DECISION NODE #2B**

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

  - **yes**
    - Imaging: alternative recommendation
      - CTPA†
      - 2
      - $\$5$
      - R4

  - **no**
    - EMERGENCY REFERRAL if patient unstable

**RESULT?**

- *(+) Result?* TREAT if DVT present. If CUS negative, CONSIDER further testing or thrombosis consult.

- *(-) Result?* REFER to obstetrics
  - CONSIDER alternative diagnosis

---

**LEGEND**

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

<table>
<thead>
<tr>
<th>Clinical Scenario</th>
<th>Urgent or Emergency Situation</th>
<th>OCEBM Level of Evidence</th>
<th>Fryback &amp; Thornbury Level of Evidence</th>
<th>Intermountain Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>II</td>
<td>R0 (0 mSv)</td>
<td>R 3 (1 – 10 mSv)</td>
<td>R 4 (10 – 30 mSv)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$ (0 – 5 RVUs)</td>
<td>$ $ (5 – 10 RVUs)</td>
<td>$ $$ (10 – 15 RVUs)</td>
</tr>
</tbody>
</table>

© 2017 INTERMOUNTAIN INTELLECTUAL ASSET MANAGEMENT, LLC, A WHOLLY OWNED SUBSIDIARY OF INTERMOUNTAIN HEALTHCARE. ALL RIGHTS RESERVED.
DECISION NODE #2A & #2B KEY EVIDENCE


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

**POINT-OF-ORDER CHECKLISTS**

The provider must check BOTH:
1. The box next to the relevant clinical scenario
2. EACH AUC box that applies to the patient’s situation

### TABLE 1. CTPA appropriate use indications

**PRIMARY recommendation**

- **Suspected PE in NON-PREGNANT patients** (IF EITHER of these 2 situations):
  - **PE highly likely** (PERC > 0 AND RGS ≥ 11)
  - **OR**
  - **PE possible** (PERC > 0 AND RGS 0 – 10 AND d-dimer positive [≥ 500, or age x10 if ≥ 50 years])

**ALTERNATIVE recommendation**

- **Suspected PE in PREGNANT patients** (ALL criteria must be met for either of the following 2 sets of conditions):
  - Abnormal CXR
  - No DVT symptoms
  - No contrast allergy AND eGFR ≥ 30
  - OR
  - Non-diagnostic V/Q Scan
  - No contrast allergy AND eGFR ≥ 30

### TABLE 2. V/Q Scan appropriate use indications

**PRIMARY recommendation**

- **Suspected PE in PREGNANT patients** (IF ALL):
  - Normal CXR
  - No DVT symptoms
  - No contrast allergy
  - eGFR ≥ 30

**ALTERNATIVE recommendation**

- **Suspected PE in NON-PREGNANT patients** (IF EITHER of these 2 situations):
  - **PE highly likely** (PERC > 0 AND RGS ≥ 11)
  - **OR**
  - **PE possible** (PERC > 0 AND RGS 0 – 10 AND d-dimer positive [≥ 500, or age x10 if ≥ 50 years])

See abbreviations on page 2.
**INTERMOUNTAIN IMAGING CRITERIA FOR**

**Suspected Pulmonary Embolism (PE)**

**RESOURCES**

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 Intermountain Imaging Criteria 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 Imaging Criteria CPMs and supporting materials, visit: [https://intermountainhealthcare.org/services/imaging-services/intermountain-imaging-criteria/](https://intermountainhealthcare.org/services/imaging-services/intermountain-imaging-criteria/).

---

**Computed Tomography (CT) Scan**

*What is a CT Scan?*

A CT scan uses x-rays to create clear, detailed images of body parts. You’ll meet with your doctor to learn about the test and how to prepare. Here are some tips:

- **You’ll meet with your doctor.** Your doctor especially needs to know if you have asthma or heart disease. If directed, avoid food and drink before the test.
- **Some CT scans use a clear liquid called contrast.** Include all herbs, vitamins, over-the-counter medications, or patches.
- **Tell your doctor and the CT technician if you are pregnant or you may be pregnant.** You may be prescribed medication to take a few days before your procedure and monitor your blood sugars.
- **If you take medications that lower blood sugar,** generally painless, fast, and easy.

**How does a CT scan work?**

**Radiation Exposure in Medical Tests**

100 people will develop cancer in their lifetime. Radiation is very small that it can’t be measured on an individual basis. Radiation exposure are often very low compared to surrounding for about 10 days.

Medical tests use very small amounts of radiation. We’re all exposed to radiation 24 hours a day from natural sources. Individual person and the site of the clot. The most common causes of DVT are:

- **Heart failure**
- **Cancer and some of its treatments**
- **Surgery (especially joint replacement, hip replacement, or vaginal birth)**
- **Injury to a deep vein from surgery, a foot injury, or surgery to the leg**
- **Birth (due to hormonal changes, less physical activity)**

The symptoms of DVT can vary depending on the level of the clot and how far it travels. They include:

- **Coughing or shortness of breath**
- **Chest pain that spreads to one arm**
- **Persistent cough that is worse when you breathe deeply**
- **Sudden, severe pain in the leg**
- **Symptoms include:**
  - Sudden, severe pain in the leg
  - Swelling
  - Redness
  - Increased temperature

Deep Vein Thrombosis and Embolism

A blood clot that has broken loose is called an embolism. DVTs are dangerous because they can break loose and travel in your veins. A blood clot in the lungs is called a pulmonary embolism (PE). It can be life-threatening.

**Other information with your doctor.**

Radiation — particularly CT scans — is a form of energy used in common medical tests. Radiographic imaging techniques, such as X-rays, separate different materials and structures by using varying amounts of energy to pass through the body. In computed tomography (CT) imaging, a computer analyzes data from multiple X-ray images taken from different angles around the body to create detailed images of body parts.

Computed tomography (CT) scans are a type of computerized imaging that uses X-rays to produce cross-sectional images of internal organs, bones, blood vessels, and other body tissues. CT scans can produce images in various planes, including axial (cross-sectional), sagittal (side view), and coronal (frontal) views. CT scans are often used in the diagnosis of diseases, monitoring of the progression of disease, and planning of treatment. CT scans can be used to examine a variety of body parts, including the brain, spine, chest, abdomen, pelvis, and extremities. They can also be used to guide procedures, such as biopsies or brushings.

**Wise Choices**

- **Discuss planned imaging procedures and inform referring providers about ionizing radiation, relative estimated exposures and potential risks of a proposed procedure.**
- **Ensuring that an ordered procedure is necessary and appropriate.**
- **With example situations when alternative imaging strategies may be preferable.**
- **Conclusively linked cancer with radiation at the levels used in imaging.** However, on the patient’s age, body size, and sex. For more details, see page 2.

**Fact sheets:**

- **Computed Tomography (CT) Scan** *(English) / (Spanish)*
- **Radiation Exposure in Medical Tests** *(English) / (Spanish)*
- **Deep Vein Thrombosis and Embolism** *(English) / (Spanish)*

---

**Related Care Process Models (CPMs):**

- **Deep Vein Thrombosis (DVT) and Embolism CPM**
- **Imaging Radiation Exposure CPM**
- **Diagnosis and Management of Venous Thromboembolism CPM**
BIBLIOGRAPHY

**NODE #1**


**NODES #2A & #2B**


REFERENCES (from pages 1 through 3)


Development Group
- Jordan Albritton, PhD, MPH
- Joseph Bledsoe, MD
- Terry Clemmer, MD
- Karen Conner, MD, MBA
- Greg Elliott, MD
- James Hellewell, MD
- David Jackson, MPH (Medical Writer)
- Kathryn Kuttler
- Nancy Nelson, RN, MS
- Ann Phan, MBA
- Scott Stevens, MD
- Keith White, MD
- Scott Woller, MD

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.