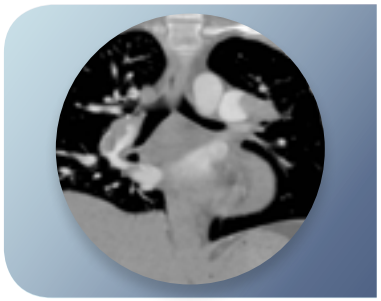

Intermountain Imaging Criteria:

Suspected Pulmonary Embolism

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.[SMI] The inflating costs of advanced imaging outstripped that of any other medical service.[IGL, GAO] These inflating costs resulted in up to $20–30 billion in unnecessary advanced imaging spending each year.[NYDH]

- **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.[LEV, CMS1]
- **Limited effectiveness.** Multiple studies suggest that up to a third of advanced imaging procedures fail to contribute to diagnosis or are clinically inappropriate.[NYDH]
- **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 an 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

Indicates an Intermountain measure

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

WHAT'S INSIDE?

OVERVIEW: INTERMOUNTAIN IMAGING CRITERIA AUC CONTENT 2

SUSPECTED PULMONARY EMBOLISM (PE) CARE PATHWAY ALGORITHMS:

Suspected acute pulmonary embolism in non-pregnant patients 5

Suspected acute pulmonary embolism in pregnant patients 7

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Intermountain Healthcare

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.[CMS2] The radiation risk is derived from data published in 2010 by the Health Physics Society.[ACR, HPS]

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

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

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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 Arabic number in the green box indicates an evidence ranking derived from the OCEBM scale.[OCE] 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.[FRY] 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:[CMS2]

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

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

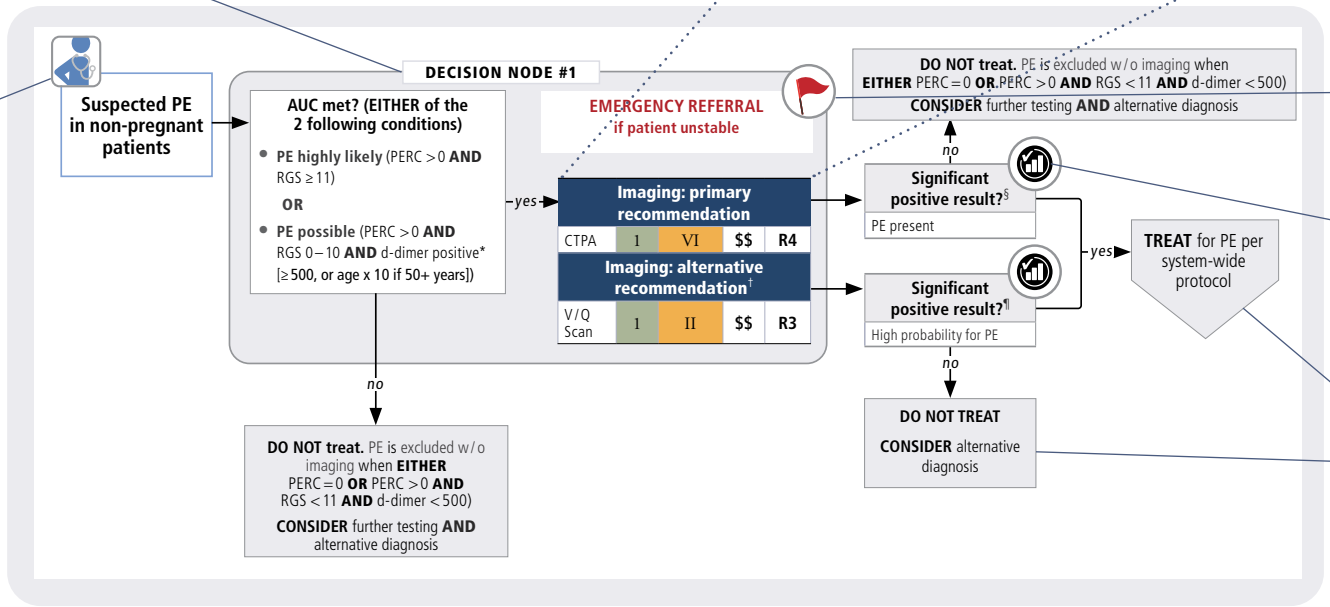
R0 = 0 mSv
R1 = < 1 mSv
R2 = 0.1 – 1 mSv
R3 = 1 – 10 mSv
R4 = 10 – 30 mSv
R5 = 30 – 100 mSv

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

Imaging: primary recommendation				
CTPA	1	VI	$$	R4
Imaging: alternative recommendation				
V/Q Scan	1	II	$$	R3

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).

This symbol indicates a common clinical scenario.



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.

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

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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.

See abbreviations on page 2.

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

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 0–1 **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**

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SUSPECTED PULMONARY EMBOLISM (PE) CARE PATHWAY ALGORITHMS

See abbreviations on page 2.

Suspected PE in non-pregnant patients

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

yes →

Imaging: primary recommendation				
CTPA	1	VI	$$	**R4**
Imaging: alternative recommendation†				
V/Q Scan	1	II	$$	**R3**

Significant positive result?§
PE present

Significant positive result?¶
High probability for PE

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

no → **DO NOT TREAT**

CONSIDER further testing **AND** alternative diagnosis

no → **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

no → **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

* 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 comoribities, imaging should be performed.

† Use imaging alternative if contrast allergy **OR** eGFR < 30.

‡ Additional testing or consultation may be pursued if persistent concern for PE, particularly in patients with high pretest probability.

§ 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.

¶ 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.

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

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DECISION NODE #1 KEY EVIDENCE

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Konstantinides SV, Meyer g, Becattini C, et al. 2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the European Society (ERS). *Eur Heart J.* 2020;41(4):543-603.

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

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.

$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

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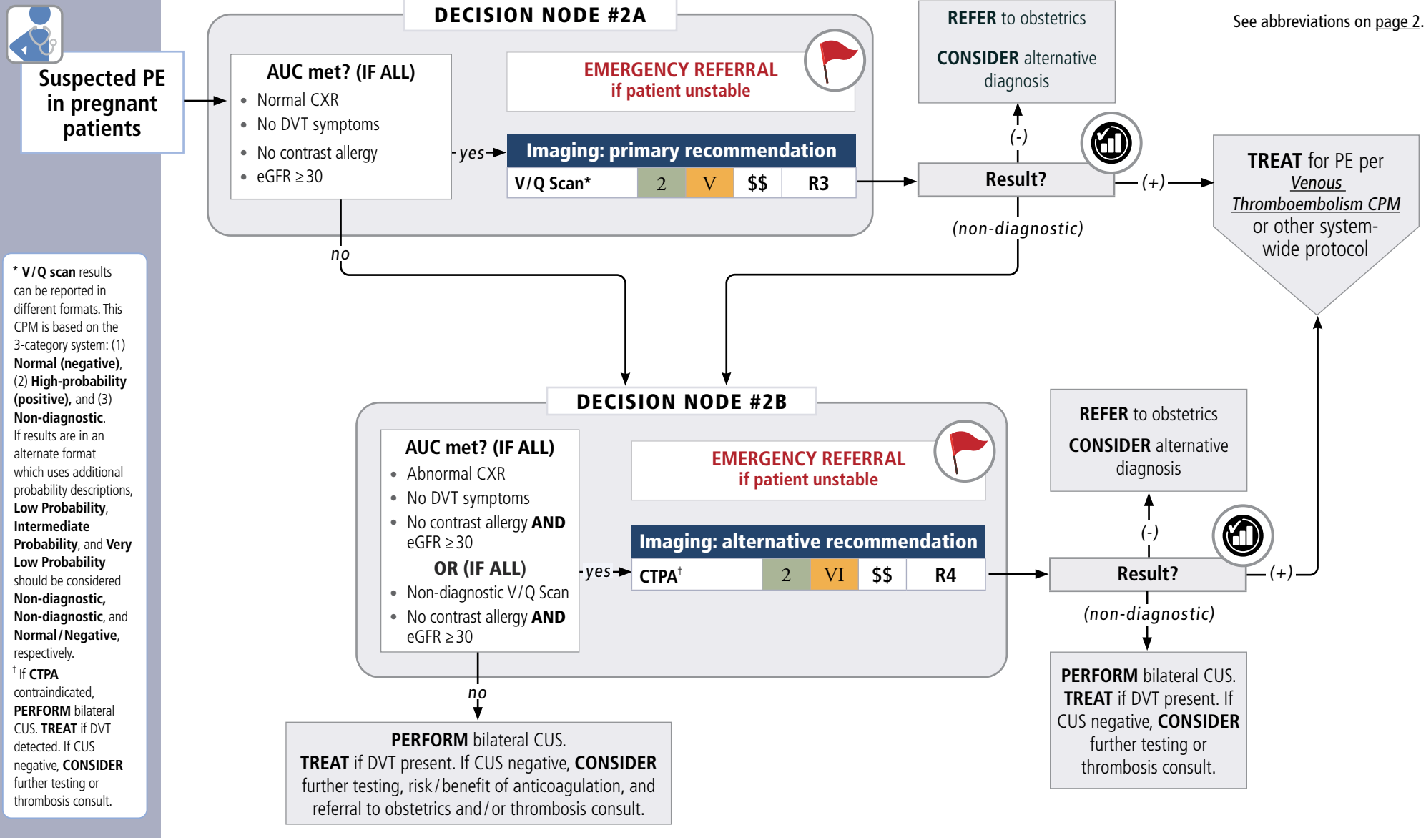
INTERMOUNTAIN IMAGING CRITERIA FOR **Suspected Pulmonary Embolism (PE)**

Intermountain® Healthcare



See abbreviations on page 2.

* **V/Q scan** results can be reported in different formats. This CPM is based on the 3-category system: (1) **Normal (negative)**, (2) **High-probability (positive),** and (3) **Non-diagnostic**. If results are in an alternate format which uses additional probability descriptions, **Low Probability**, **Intermediate Probability**, and **Very Low Probability** should be considered **Non-diagnostic, Non-diagnostic**, and **Normal/Negative**, respectively.

† If **CTPA** contraindicated, **PERFORM** bilateral CUS. **TREAT** if DVT detected. If CUS negative, **CONSIDER** further testing or thrombosis consult.

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **$** (0–5 RVUs) | **R3** (1–10 mSv) **$$** (5–10 RVUs) | **R4** (10–30 mSv) See page 2–3 for explanation. **$$$** (10–15 RVUs) **$$$$** (15+ RVUs)

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DECISION NODE #2A & #2B KEY EVIDENCE

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

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.

$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

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POINT-OF-ORDER CHECKLISTS

See abbreviations on page 2.

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])

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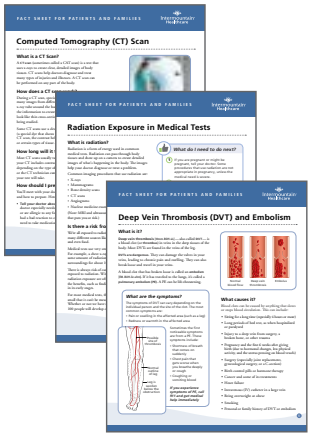
RESOURCES

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 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/.

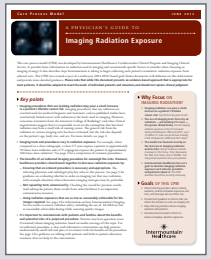


Fact sheets:

- *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):

Diagnosis and Management of Venous Thromboembolism CPM



Imaging Radiation Exposure CPM

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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.

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