PE Board Review 2026

Tareq Zaza

2026 AHA/ACC/ACCP/ACEP/CHEST/SCAI/SHM/SIR/SVM/SVN Guideline for the Evaluation and Management of Acute Pulmonary Embolism in Adults

A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

Tareq Zaza

Objectives

Board review focus review

Starting with diagnosis, appropriate classification, going through treatment and management, appropriate follow up, and evaluation of possible complications

A touch on guidelines and evidence-based medicine

During this journey, we will try to touch on how guidelines are developed, and how to appropriately apply it to your clinical practice and for board review

Class of Recommendation CoR and Level of Evidence LOE



CLASS (STRENGTH) OF RECOMMENDATION

Class 1 (STRONG) — **Benefit >>> Risk**

Suggested phrases for writing recommendations:
- Is recommended
- Is indicated/useful/effective/beneficial
- Should be performed/administered/other
- Comparative-Effectiveness Phrases†:
  - Treatment/strategy A is recommended/indicated in preference to treatment B
  - Treatment A should be chosen over treatment B

Class 2a (MODERATE) — **Benefit >> Risk**

Suggested phrases for writing recommendations:
- Is reasonable
- Can be useful/effective/beneficial
- Comparative-Effectiveness Phrases†:
  - Treatment/strategy A is probably recommended/indicated in preference to treatment B
  - It is reasonable to choose treatment A over treatment B

Class 2b (WEAK) — **Benefit ≥ Risk**

Suggested phrases for writing recommendations:
- May/might be reasonable
- May/might be considered
- Usefulness/effectiveness is unknown/unclear/uncertain or not well-established

Class 3: No Benefit (MODERATE) — **Benefit = Risk**
(Generally, LOE A or B use only)

Suggested phrases for writing recommendations:
- Is not recommended
- Is not indicated/useful/effective/beneficial
- Should not be performed/administered/other

Class 3: HARM (STRONG) — **Risk > Benefit**

Suggested phrases for writing recommendations:
- Potentially harmful
- Causes harm
- Associated with excess morbidity/mortality
- Should not be performed/administered/other

LEVEL (QUALITY) OF EVIDENCE‡

Level A
- High-quality evidence‡ from more than 1 RCT
- Meta-analyses of high-quality RCTs
- One or more RCTs corroborated by high-quality registry studies

Level B-R (Randomized)
- Moderate-quality evidence‡ from 1 or more RCTs
- Meta-analyses of moderate-quality RCTs

Level B-NR (Nonrandomized)
- Moderate-quality evidence‡ from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies
- Meta-analyses of such studies

Level C-LD (Limited Data)
- Randomized or nonrandomized observational or registry studies with limitations of design or execution
- Meta-analyses of such studies
- Physiological or mechanistic studies in human subjects

Level C-EO (Expert Opinion)
- Consensus of expert opinion based on clinical experience

COR and LOE are determined independently (any COR may be paired with any LOE).

A recommendation with LOE C does not imply that the recommendation is weak. Many important clinical questions addressed in guidelines do not lend themselves to clinical trials. Although RCTs are unavailable, there may be a very clear clinical consenus that a particular test or therapy is useful or effective.

* The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental prognostic information).

† For comparative-effectiveness recommendations (COR 1 and 2a; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

‡ The method of assessing quality is evolving, including the application of standardized, widely-used, and preferably validated evidence grading tools; and for systematic reviews, the incorporation of an Evidence Review Committee.

COR indicates Class of Recommendation; EO, expert opinion; LD, limited data; LOE, Level of Evidence; NR, nonrandomized; R, randomized; and RCT, randomized controlled trial.

Acute Pulmonary Embolism in Adults

EVALUATION AND DIAGNOSIS

Clinical Assessment

The most common symptoms of PE are pleuritic chest pain and dyspnea

Hemoptysis, syncope, and shock are less common

Physical examination findings

Tachycardia is common

Hypotension may indicate hemodynamic compromise

Tachypnea and hypoxemia may indicate a significant degree of gas exchange disturbance.

Other signs

Decreased lung breath sounds, a pleural friction rub, jugular venous distension, an accentuated pulmonic second heart sound, a parasternal lift, and leg swelling and tenderness suggestive of deep vein thrombosis (DVT)

EVALUATION AND DIAGNOSIS

- Relevant **history**, physical **examination**, and PE **pretest probability scores** guide appropriate investigations for potential cardiopulmonary diagnoses

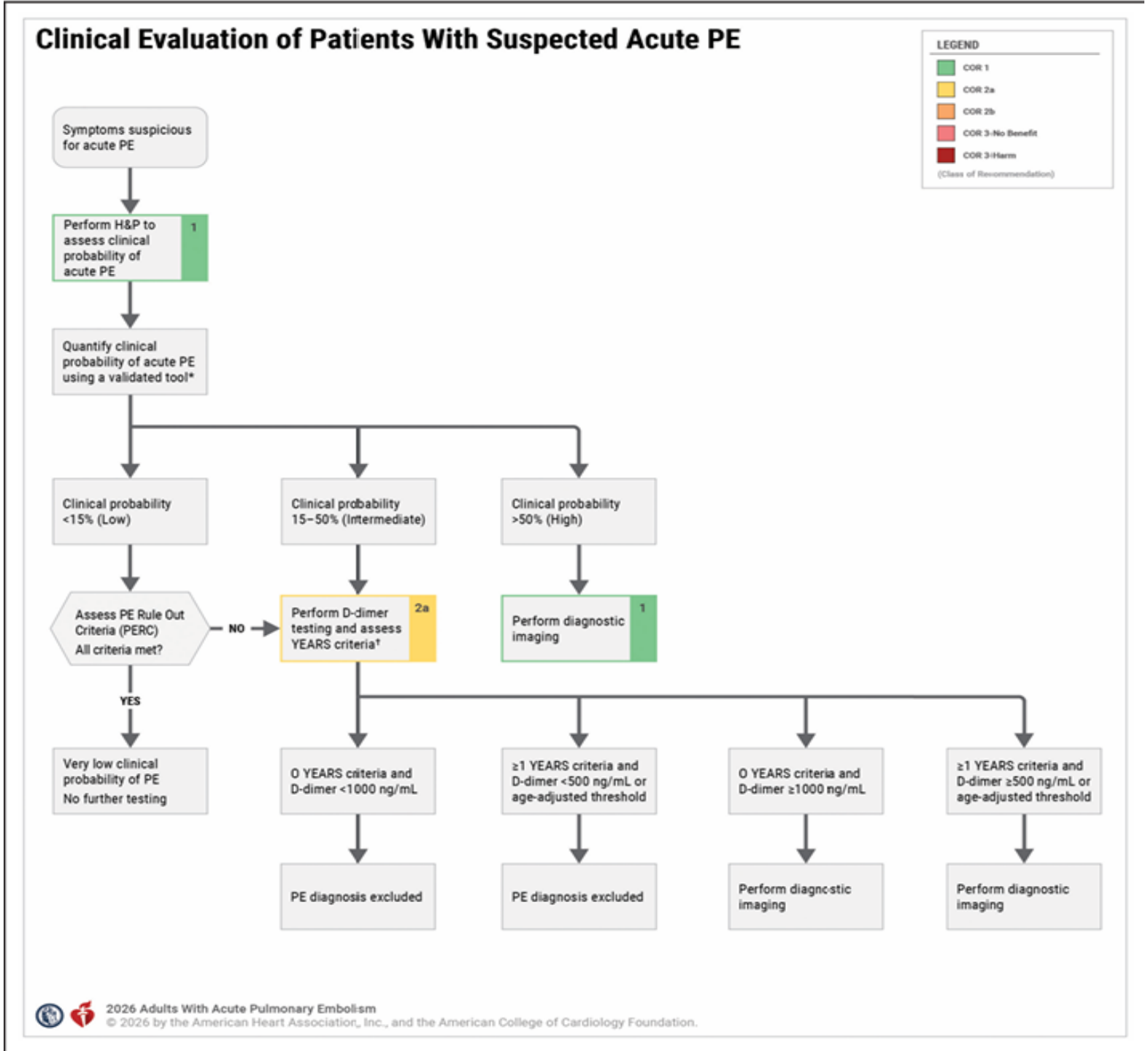
- **Clinical decision tools** that incorporate assessment of clinical suspicion of PE with laboratory testing are recommended to identify patients in whom diagnostic imaging is warranted from those in whom the diagnosis is unlikely and therefore imaging can be avoided.

Clinical Evaluation of Patients With Suspected Acute PE

YEARS algorithm
1) clinical signs of DVT
2) hemoptysis
3) PE as the most likely diagnosis

A D-dimer threshold of 500 µg/L in patients who have ≥1 YEARS criteria

A D-dimer threshold of 1000 µg/L



Clinical Decision Rules

Clinical Pretest Probability Score	Components	Points		Clinical Pretest Probability Grouping and Utilization
Wells Score for PE[28]	Clinical symptoms of DVT (leg swelling, pain with palpitation)	3		**Standard Wells Scoring:** Low: <2 Moderate: 2-6 High: >6 **Modified Wells Scoring:** PE likely: >4 PE unlikely: ≤4
	PE more likely than other diagnoses	3		
	Heart rate >100 bpm	1.5		
	Immobilization (≥3 days) or surgery in the previous 4 weeks	1.5		
	Previous DVT or PE	1.5		
	Hemoptysis	1		
	Cancer	1		

		Revised Geneva Score	Simplified Revised Geneva Score	
Revised Geneva Score[29,30]	Age >65	1	1	**Revised Geneva:** Low: 0-3 Intermediate: 4-10 High: ≥11 **Simplified Revised Geneva:** Low: 0-1 Intermediate: 2-4 High: 5-7 Unlikely: 0-2 Likely: 3-7
	Previous DVT or PE	3	1	
	Surgery under general anesthesia or fracture of the lower limbs within 1 months	2	1	
	Active cancers	2	1	
	Unilateral lower-limb pain	3	1	
	Hemoptysis	2	1	
	Heart rate 75-94 bpm	3	1	
	Heart rate ≥95 bpm	5	1	
	Pain on lower limb deep vein palpation and unilateral edema	4	1	

PE Rule Out Criteria (PERC)

PE Rule Out Criteria[21]	Age <50 years			Assess if clinical pretest probability (gestalt) of PE is <15% (eg, Wells <2) When all criteria are met, the likelihood of PE is low and no further testing is required.
	Heart rate <100 bpm			
	Oxyhemoglobin saturation ≥95%			
	No hemoptysis			
	No estrogen use			
	No prior DVT or PE			
	No unilateral leg swelling			
	No surgery/trauma requiring hospitalization within the prior 4 weeks			

Clinical Evaluation of Patients With Suspected Acute PE

The accepted safety threshold (ie, failure rate) for diagnostic tools in the evaluation of PE is 2%

Acute PE is unlikely in patients who meet all 3 of the following criteria:

1) D-dimer levels that do not exceed the threshold of normal

2) a low or intermediate clinical pretest probability (<50%) of PE

3) are not anticoagulated at base line

Clinical Assessment Guidelines Recommendation

Recommendations for Clinical Assessment
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	Recommendations
1	A	1. In patients presenting with symptoms suggestive of acute PE, a targeted history and comprehensive physical examination is recommended to assist in determining the clinical pretest probability of acute PE.[1,2]
2a	B-R	2. In adult patients undergoing evaluation for PE and who have a low or intermediate clinical probability of PE (<50%) by risk assessment, an age-adjusted D-dimer value below the threshold (age × 10 µg/L for fibrinogen equivalent units assays) effectively excludes PE and the need for imaging.[2–5]
2a	B-R	3. In adult patients with suspected PE, the YEARS algorithm* can be useful to identify which patients do not need imaging to rule out a PE.[2,3,6,7]
2b	B-NR	4. In pregnant adults, it may be reasonable to use pregnancy-adapted YEARS criteria to identify patients who do not need imaging for PE.[8–10]

Diagnostic Testing

Recommendations for Diagnostic Testing

In patients undergoing imaging evaluation for suspected PE, a positive CTPA or high probability ventilation/perfusion (V/Q) scan *is sufficient to diagnose PE*. **1 A**

In patients undergoing imaging evaluation, a CTPA is recommended in preference to a V/Q scan to confirm the diagnosis of acute PE. **1 BR**

- higher detection of peripheral (noncentral) PE on CTPA compared with V/Q scans
- RV can be assessed in the presence of confirmed PE

In pregnant patients presenting with symptoms, YEARS criteria suggestive of acute PE, and a normal chest x-ray, imaging evaluation with *low radiation dose CTPA* is reasonable over low-dose perfusion scintigraphy **2A B NR**

- Retrospective data from an academic center with experience in low-dose perfusion scintigraphy-only lung scanning demonstrated 100% negative predictive value for the exclusion of PE in pregnant patients who had no abnormalities on chest x-ray.

Recommendations for Diagnostic Testing

- In patients with a clinically probable PE, as assessed by available clinical tools and laboratory D-dimer testing, *a positive CTPA is definitive* for the diagnosis of PE as a stand-alone test

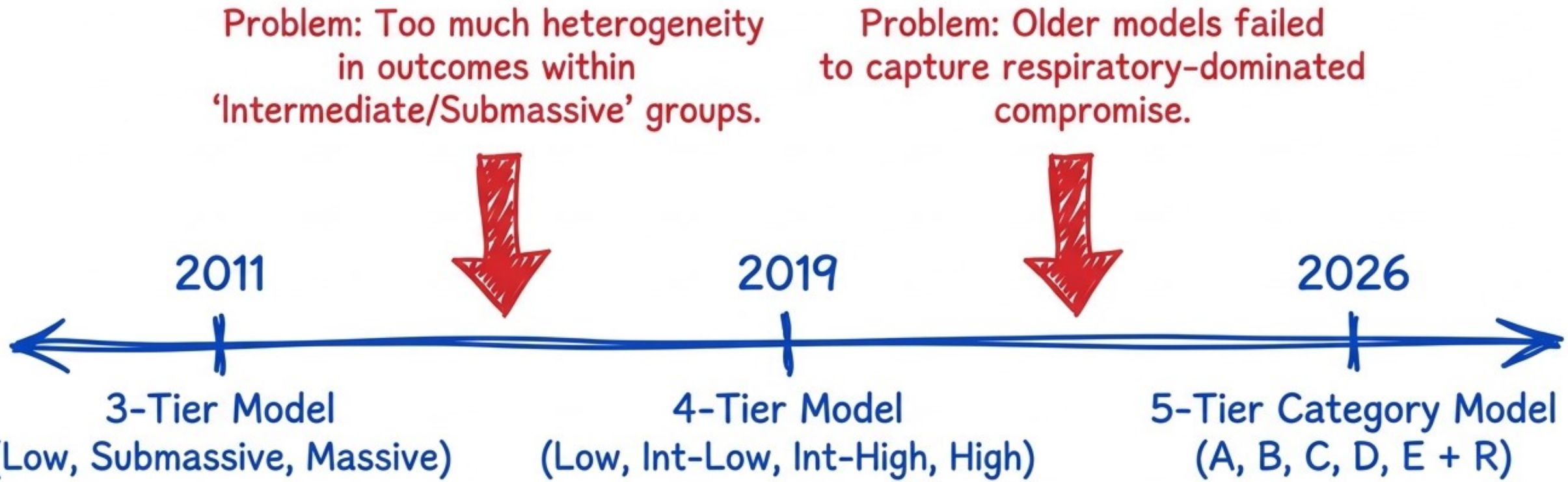
- A high probability V/Q scan has *excellent diagnostic accuracy* for acute PE in this clinical setting. It is the imaging modality of choice in patients who cannot undergo CTPA (eg, patients with contraindication to CT)

- In patients with suspected acute PE who cannot undergo a CTPA, it is reasonable to perform a V/Q scan in preference to contrast-enhanced magnetic resonance angiography (MRA) to improve the

PE Outcomes Risk Stratification

PE represents a wide spectrum of presentations, ranging from asymptomatic disease to cardiogenic shock and cardiac arrest

Accordingly, PE necessitates swift and precise risk assessment to determine prognosis, guide therapeutic decision-making, and improve patient outcomes.



2026 Goal: Enhance precision for triage, prognosis, and advanced therapy decisions.

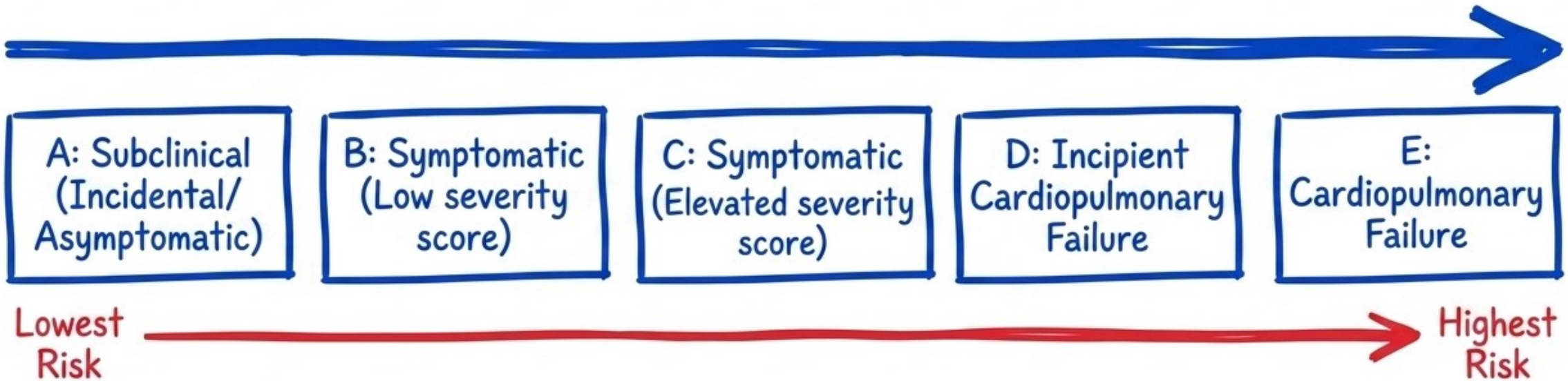
NotebookLM



The limitation: Rigid dependence on hemodynamics while ignoring the spectrum of sub-clinical and respiratory factors.

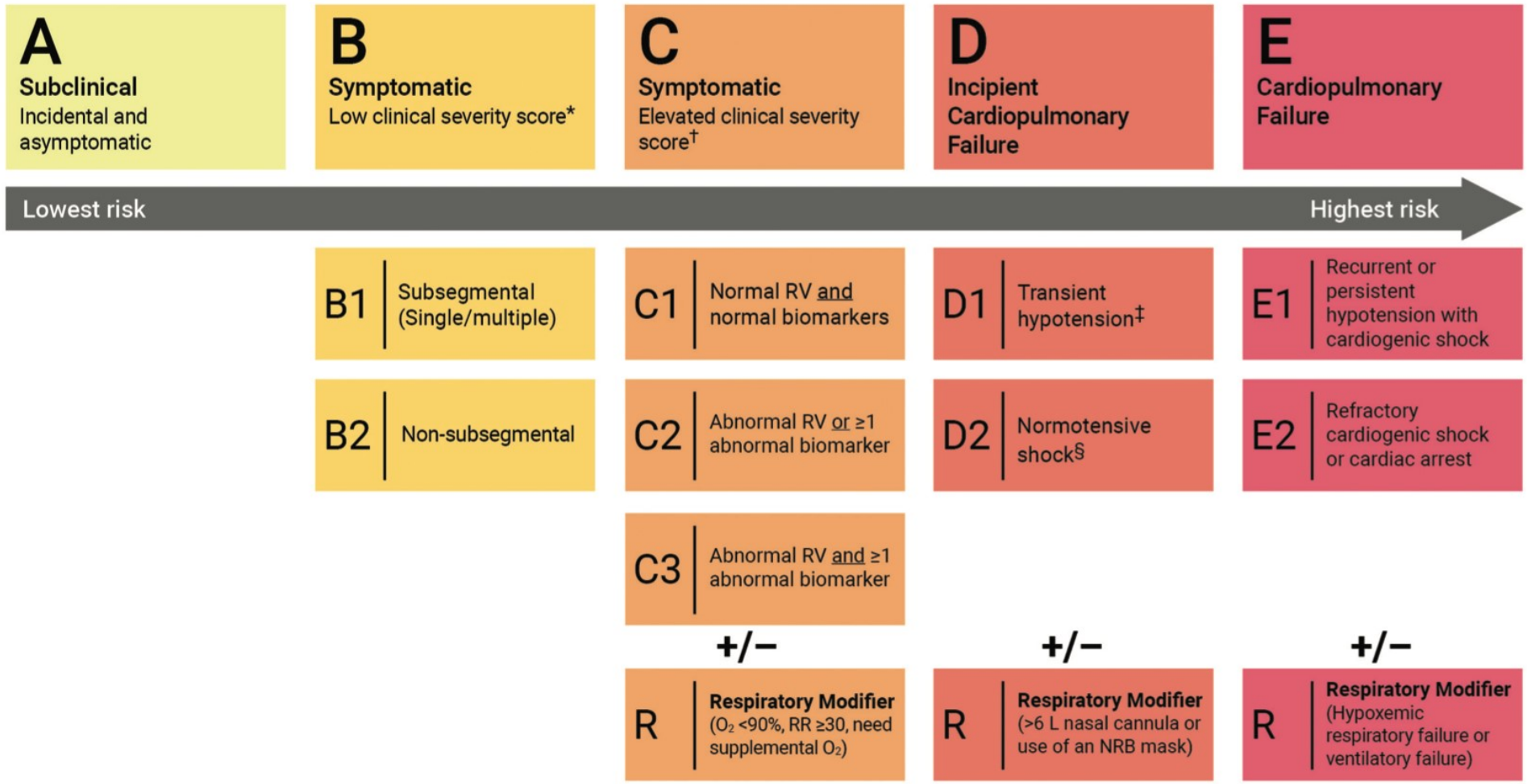
NotebookLM

The new standard: 5 distinct categories accounting for clinical severity, hemodynamics, biomarkers, and RV function.



NotebookLM

AHA/ACC Acute PE Clinical Categories



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Risk Assessment Using Clinical Risk Scores

Risk Score Name	Risk Score Components	Range of Risk Score	Risk Categories and Definitions
PESI	Age Male (10 pts) History of cancer (30 pts) History of heart failure (10 pts) Chronic lung disease, (10 pts) Heart rate ≥110 bpm (20 pts) Systolic blood pressure <100 mm Hg (30 pts) Respiratory rate ≥30 bpm (20 pts) Temperature <36°C (20 pts) Altered mental status (60 pts) Oxygen saturation <90% (20 pts) Calculate score by adding age (in years) and points by risk factor	Class I to V	Class I (lowest risk): ≤65 pts Class II: 66-85 pts Class III: 86-105 pts Class IV: 106-125 pts Class V: (highest risk) ≥126 pts
sPESI	Age >80 yrs History of cancer Chronic cardiopulmonary disease Systolic blood pressure <100 mm Hg Heart rate ≥110 bpm Arterial oxygen saturation <90% Calculate score by adding 1 pt for each of the risk factors	Low or High	0 points: Low risk of 30-day mortality ≥1 point: High risk of 30-day mortality

Bova Score	Systolic blood pressure 90-100 mm Hg (2 pts) Cardiac troponin elevation (2 pts) Right ventricular dysfunction (2 pts) Heart rate ≥110 bpm (1 pt) Calculate score by adding pts for each of the risk factors	0 to 7	Stage I (lowest risk): 0-2 pts Stage II: 3-4 pts Stage III (highest risk): >4 pts
Hestia Criteria	Is the patient hemodynamically unstable? Is thrombolysis or embolectomy necessary? Does the patient have active bleeding or a high risk of bleeding? Does the patient require >24 hours of oxygen to maintain oxygen saturation >90%? Is pulmonary embolism diagnosed during anticoagulant treatment? Does the patient have severe pain requiring intravenous pain medication for >24 h? Are there medical or social reasons for hospitalization >24 hours (eg, infection, cancer, lack of support system)? Does the patient have a creatinine clearance of <30 mL/min? Does the patient have severe liver impairment? Is the patient pregnant? Does the patient have a documented history of heparin-induced thrombocytopenia?	Negative versus Positive	If answers to all criteria are "No," the Hestia rule is negative; consider outpatient management. If answer to ≥1 of the criterion is "Yes," the Hestia rule is positive; consider hospitalization.

Low Clinical Severity Score includes PESI ≤85 or sPESI =0 or Bova ≤ 4.

Elevated Clinical Severity Score includes PESI >85 or sPESI ≥1 or Bova> 4

Risk Assessment Using Clinical Risk Scores

- The Hestia, PESI, and sPESI scores *can all identify patients at low risk for short-term adverse outcomes*, such as all-cause mortality, PE-related mortality, recurrent thromboembolism, and major bleeding

- *Risk scores are most accurate in identifying patients with a low risk of short-term adverse outcomes*

- *Hestia, PESI, and sPESI all have good predictive ability in identifying low-risk patients suitable for outpatient management*

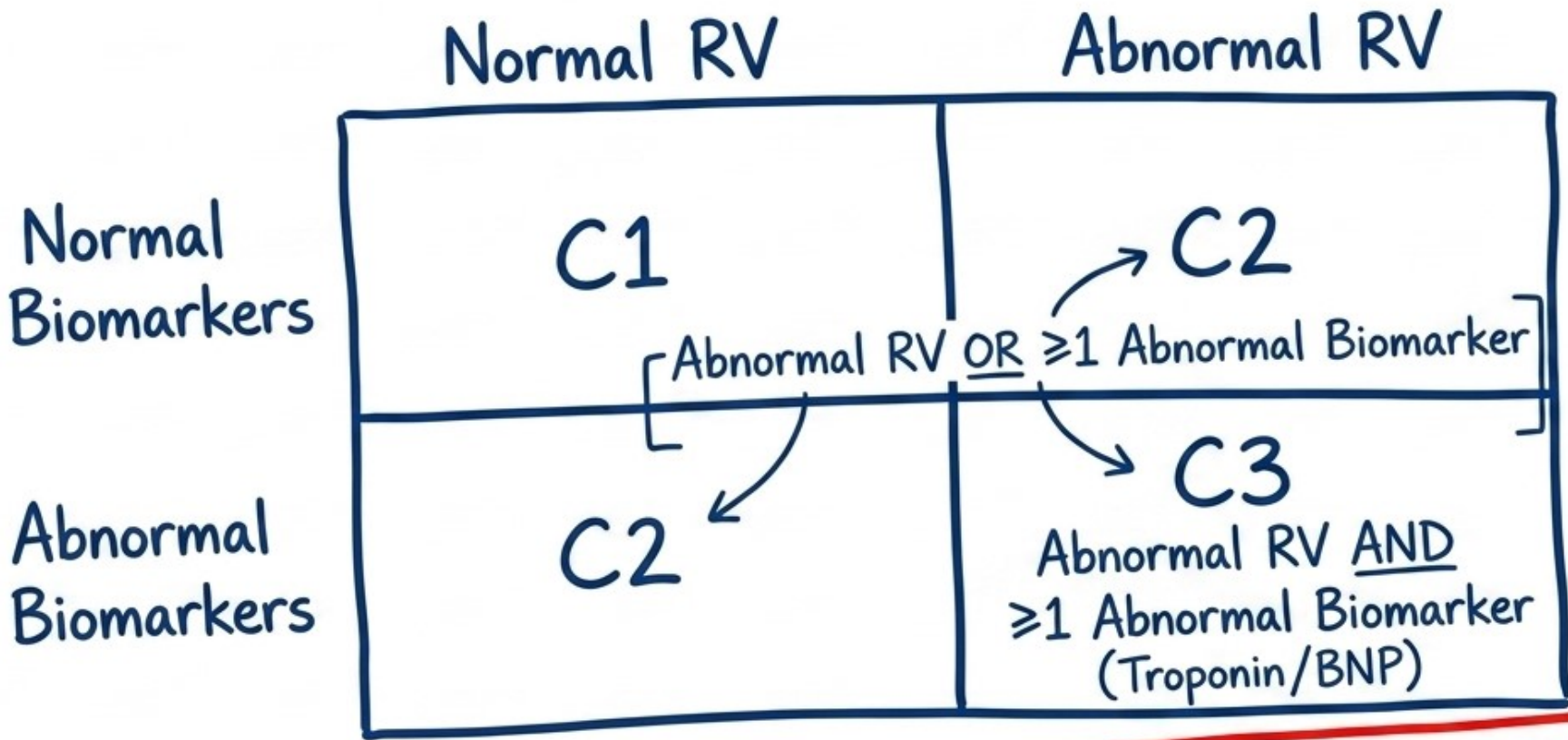
Risk Assessment Using Clinical Risk Scores

- It has been more challenging to identify which patients will do poorly

- Although scores generally show modest to good discriminatory ability in separating patients by their probability of developing adverse outcomes, *none of the currently available risk scores strongly predict clinical deterioration in patients with hemodynamically stable PE*

- Generic measures of risk, such as the Shock Index, the NEWS, and its updated version, NEWS2, have also been compared with PE-specific risk scores in their ability to predict which hemodynamically stable patients will develop short-term adverse outcomes, and in some studies have shown comparable

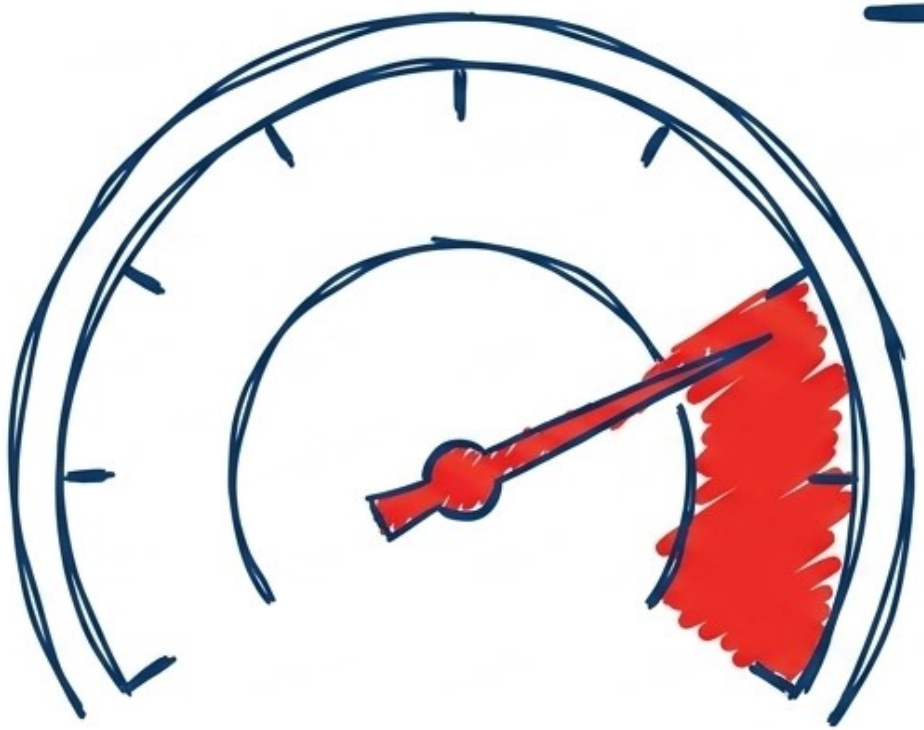
Category C: Symptomatic + Elevated Severity Score
(e.g., PESI >85, sPESI ≥=1)



The "+R" Modifier: Add "R" (e.g., C3R) if patient has O_2 <90%, RR ≥30, or needs supplemental O_2.

Gemini Notebook

Category D: Incipient Cardiopulmonary Failure



D1: Transient Hypotension (Systolic BP <90 or drop >40 mmHg lasting <15 min, or responding to IV fluids).

D2: Normotensive Shock (Lactate >2, acute kidney injury, mental status change).

The "+R" Modifier:
Add "R" if requiring >6L nasal cannula or use of a Non-Rebreather (NRB) mask.

Gemini Notebook

Category E: Cardiopulmonary Failure

The Highest Risk Category - Systemic Collapse



- E1: Recurrent or persistent hypotension with cardiogenic shock.
- E2: Refractory cardiogenic shock or cardiac arrest.

The "+R" Modifier:
Add "R" for Hypoxemic respiratory failure or ventilatory failure.

Gemini Notebook

Biomarkers for Risk Stratification

Recommendations for Risk Stratification of PE Using Biomarkers
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	Recommendations
1	B-NR	1. In patients with acute PE and an elevated clinical severity score without features of hypotension or shock (ie, AHA/ACC PE Category C), measurement of at least 1 cardiac biomarker (ie, troponin, brain natriuretic peptide [BNP]) is recommended to assist with risk stratification for short-term complications and/or mortality.[1–11]

Recommendations for Risk Stratification of PE Using Biomarkers (Continued)

COR	LOE	Recommendations
1	B-NR	2. In patients with acute PE (ie, AHA/ACC PE Categories C to E) who are undergoing evaluation at an acute care facility, measurement of lactate (either venous or arterial) is recommended to assist with risk stratification for short-term complications and/or mortality.[12–18]

Quantification of Thrombus Burden for Short-Term Risk Stratification

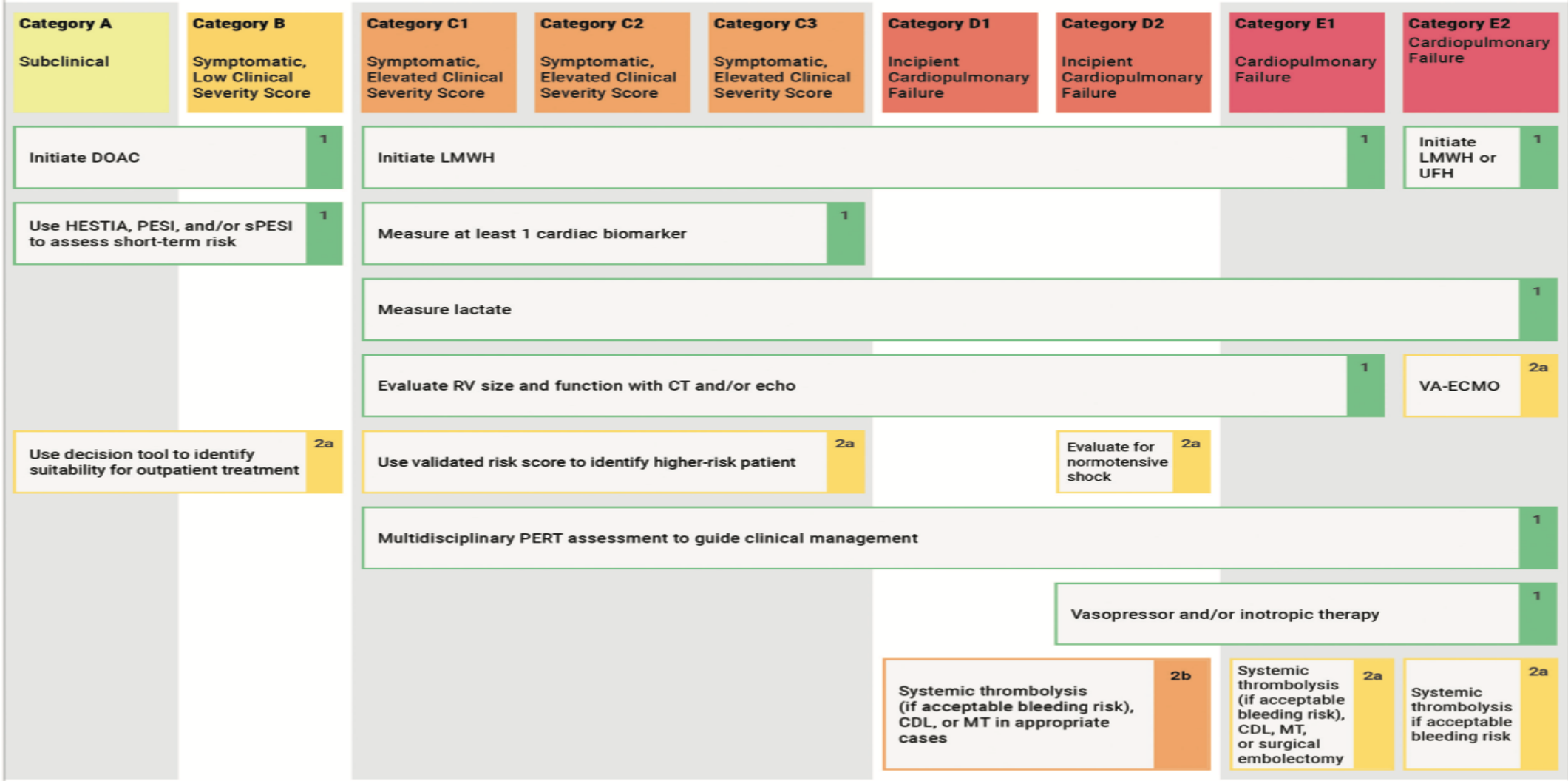
Recommendation for Quantification of Thrombus Burden for Short-Term Risk Stratification
Referenced studies that support the recommendation are summarized in the Evidence Table.

COR	LOE	Recommendation
3: No Benefit	**B-NR**	1. In patients with acute PE in AHA/ACC PE Categories A-C, quantification of angiographic thrombus burden for short-term risk stratification is not recommended.[1-4]

- A meta-analysis of 19 studies reporting on the prognostic value of CT-assessed embolic burden observed *no direct correlation between a high obstruction index and prognosis*
- prospective observational cohort study of 271 patients with PE also showed *no association between thrombus burden and adverse clinical events*
- A retrospective observational cohort study of 1743 patients with CT-confirmed PE found *no association between proximal thrombus burden and all-cause 30-day mortality*

ACUTE MANAGEMENT

Initial Assessment and Management by AHA/ACC Acute PE Clinical Categories



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Suitability for Outpatient Management of PE

The HOME-PE trial (Hestia rule or the sPESI)

There was no significant difference in the composite rate of recurrent VTE, major bleeding, or all-cause death between the groups within 30 days of randomization

A Cochrane review meta-analysis of 2 RCTs concluded there was no significant difference in the relative risk of all-cause mortality (at 30 or 90 days), major bleeding, minor bleeding, or recurrent VTE at 90 days (all outcomes had low-certainty evidence).

Recommendations for Suitability for Outpatient Management of PE
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	Recommendations
2a	B-R	1. In patients diagnosed with acute PE in a clinic or an ED, it is reasonable to use a decision tool* to identify suitability for outpatient treatment.[1]
2a	B-R	2. In select patients diagnosed with acute PE in AHA ACC PE Categories A and B in a clinic or ED, outpatient treatment† is a reasonable option compared with hospitalization, when the rate of 90-day adverse outcomes is low and it aligns with patient goals.[2]

Medical Management Anticoagulation Therapy

- In patients with acute PE who are eligible for oral anticoagulation, DOACs are recommended over vita min K antagonists (VKAs), unless contraindicated, to prevent recurrent VTE and reduce major bleeding. **COR 1**

- In patients with acute PE in AHA/ACC Categories C1-E1 who require parenteral anticoagulant therapy initially, LMWH is recommended over UFH to reduce recurrent VTE and major bleeding. **COR 1**

Anticoagulation Therapy and Special Considerations

Thrombotic Antiphospholipid Antibody Syndrome

In patients with acute PE and established thrombotic antiphospholipid antibody syndrome, a *VKA is recommended in preference to a DOAC* for the prevention of venous and arterial thrombosis. **1A**

- the studies have consistently shown an increase in the risk of subsequent arterial thrombotic events among patients with thrombotic APS who are treated with DOACs versus VKAs

In patients with acute PE determined to have only a single anticardiolipin antibody or a β2-glycoprotein antibody, a DOAC might be a reasonable alternative to a VKA to prevent recurrent PE. **2B BR**

Chronic Kidney Disease

- In patients with mild-to-moderate **(stage 2-3)** chronic kidney disease (CKD) and acute PE who require oral anticoagulant therapy, a DOAC is recommended over a VKA to reduce major bleeding

- In patients with severe kidney disease **(stage 4-5**) or end stage kidney disease on hemodialysis and confirmed PE who require oral anticoagulant therapy, it is **uncertain** whether apixaban is better than VKA to reduce major bleeding

Pregnancy

In patients who are pregnant and have acute PE, DOACs and warfarin are potentially harmful and may result in miscarriages or fetal anomalies.

3 Harm C-LD

In patients with acute PE who are *breastfeeding* and require anticoagulation, *LMWH, UFH, or warfarin* are recommended over a DOAC, to prevent potential bleeding in the infant. **1 C-LD**

Anticoagulation Therapy and Endovascular Procedure

Anticoagulation Therapy and Endovascular Procedures		
1	C-LD	18. In patients with acute PE undergoing CDL, concurrent therapeutic anticoagulation (LMWH or UFH) or subtherapeutic anticoagulation (UFH) is recommended over no anticoagulation to prevent recurrent PE.[3,29]
1	B-NR	19. In patients with acute PE who have undergone an endovascular procedure or received thrombolytic therapy, initial parenteral anticoagulation with LMWH is preferred over UFH to provide reliable therapeutic anticoagulation and reduce the risk of recurrent VTE.[30–32]
2a	C-LD	20. In patients with acute PE likely to undergo endovascular procedures for PE management, LMWH is reasonable over UFH to provide more effective anticoagulation.[29]

Thrombolytics

Is reasonable E 1-2

may be considered D 1-2

Is uncertain C 3

Should not be used C1 -2

Recommendations for Systemic Thrombolysis
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	Recommendations
2a	C-LD	1. In patients with acute PE in AHA/ACC PE Categories E1-2 and acceptable bleeding risk, in whom advanced therapy is being considered, systemic thrombolysis and anticoagulation is reasonable over anticoagulation alone to reduce mortality and recurrent PE.[1–3]
2b	C-LD	2. In patients with acute PE in AHA/ACC PE Categories D1-2 and an acceptable bleeding risk, in whom advanced therapy is being considered, systemic thrombolysis and anticoagulation may be considered over anticoagulation alone to prevent further clinical deterioration.[1,4]
2b	C-LD	3. In patients with acute PE in AHA/ACC PE Category C3 and acceptable bleeding risk, in whom advanced therapy is being considered, the use of systemic thrombolysis and anticoagulation over anticoagulation alone to prevent further clinical deterioration is uncertain.[1,4,5]
2b	C-LD	4. In patients with acute PE being treated with systemic thrombolysis, lower dose systemic thrombolytics may be considered to reduce the risk of bleeding.[6–10]
3: Harm	B-R	5. In patients with acute PE in AHA/ACC PE Categories A1-C2, systemic thrombolysis should not be used over anticoagulation alone due to increased risk of major bleeding and ICH.[5,11,12]

Catheter-Directed Thrombolysis

Recommendations for Catheter-Directed Thrombolysis
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	Recommendations
2a	C-LD	1. In patients with acute PE in AHA/ACC PE Category E1, CDL plus anticoagulation is reasonable to prevent further clinical deterioration and early mortality.[1,8]
2b	B-NR	2. In patients with acute PE in AHA/ACC PE Categories D1-2 in whom advanced therapy is being considered, CDL plus anticoagulation may be considered to prevent further clinical deterioration.[2]

Catheter-Directed Thrombolysis

Recommendations for Catheter-Directed Thrombolysis (Continued)		
COR	**LOE**	**Recommendations**
2b	**C-LD**	3. In patients with acute PE in AHA/ACC PE Categories C2-3, the benefit of CDL plus anticoagulation compared with anticoagulation alone to prevent short-term fatal/nonfatal clinical deterioration, and improve long-term mortality, functional capacity, and quality of life is unclear.[3]
2b	**C-LD**	4. In patients with acute PE in AHA/ACC PE Categories D1-E1 in whom thrombolysis is being considered, the efficacy of CDL over systemic thrombolysis to reduce short-term fatal/nonfatal clinical deterioration, and improve long-term survival, functional capacity, and quality of life is unclear, but CDL may be considered over systemic thrombolysis to reduce major bleeding risks.[4]

Mechanical Thrombectomy

Recommendations for Mechanical Thrombectomy
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	Recommendations
2a	B-NR	1. In patients with acute PE in AHA/ACC PE Category E1, it is reasonable to choose MT plus anticoagulation over anticoagulation alone to prevent further clinical decompensation and acute mortality.[1–3]
2b	B-NR	2. In patients with acute PE in AHA/ACC PE Categories D1-2 in whom advanced therapy is being considered, MT plus anticoagulation may be considered over anticoagulation alone to prevent further clinical deterioration.[4–6]
2b	C-LD	3. In patients with acute PE in AHA/ACC PE Categories C2-3, the benefit of MT plus anticoagulation compared with anticoagulation alone is unclear in preventing short-term fatal/nonfatal clinical deterioration and improving long-term survival and functional capacity.[7]
2b	B-NR	4. In patients with acute PE in AHA/ACC PE Categories D1-E1 in whom advanced therapy is being considered, the efficacy of MT to reduce short-term fatal/nonfatal clinical deterioration and improve long-term survival, functional capacity, and quality of life over systemic thrombolysis is unclear, but MT may be considered over systemic thrombolysis to reduce major bleeding risks.[3,6]

CDT Vs MT

Recommendations for Interventional Advanced Management (Continued)		
COR	**LOE**	**Recommendations**
2b	**B-R**	2. In patients with acute PE in AHA/ACC PE Categories C2-D2 and without contraindications to thrombolysis, and in whom advanced therapy is being considered, the usefulness of either CDL or MT over the other is uncertain for reduction in mortality or major bleeding.[2]

Surgical Embolectomy

Recommendations for Surgical Embolectomy
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	Recommendations
2a	B-NR	1. In patients with acute PE in AHA/ACC PE Category E1, surgical embolectomy compared with anticoagulation alone is reasonable to prevent further clinical decompensation and acute mortality.[1–5]
2b	C-LD	2. In patients with acute PE in AHA/ACC PE Categories D1-2 in whom advanced treatment is being considered, surgical embolectomy plus anticoagulation may be considered over anticoagulation alone to prevent further clinical deterioration.[1–5]
2b	B-NR	3. In patients with acute PE in AHA/ACC PE Categories D1-E1 who are surgical candidates and in whom advanced therapy is being considered, the benefits of surgical embolectomy to reduce short-term fatal/nonfatal clinical deterioration and improve long-term survival, functional capacity, and quality of life over systemic thrombolysis is unclear, but surgical embolectomy may be considered over systemic thrombolysis to reduce the risk of ICH.[4-8,12]

Surgical Embolectomy

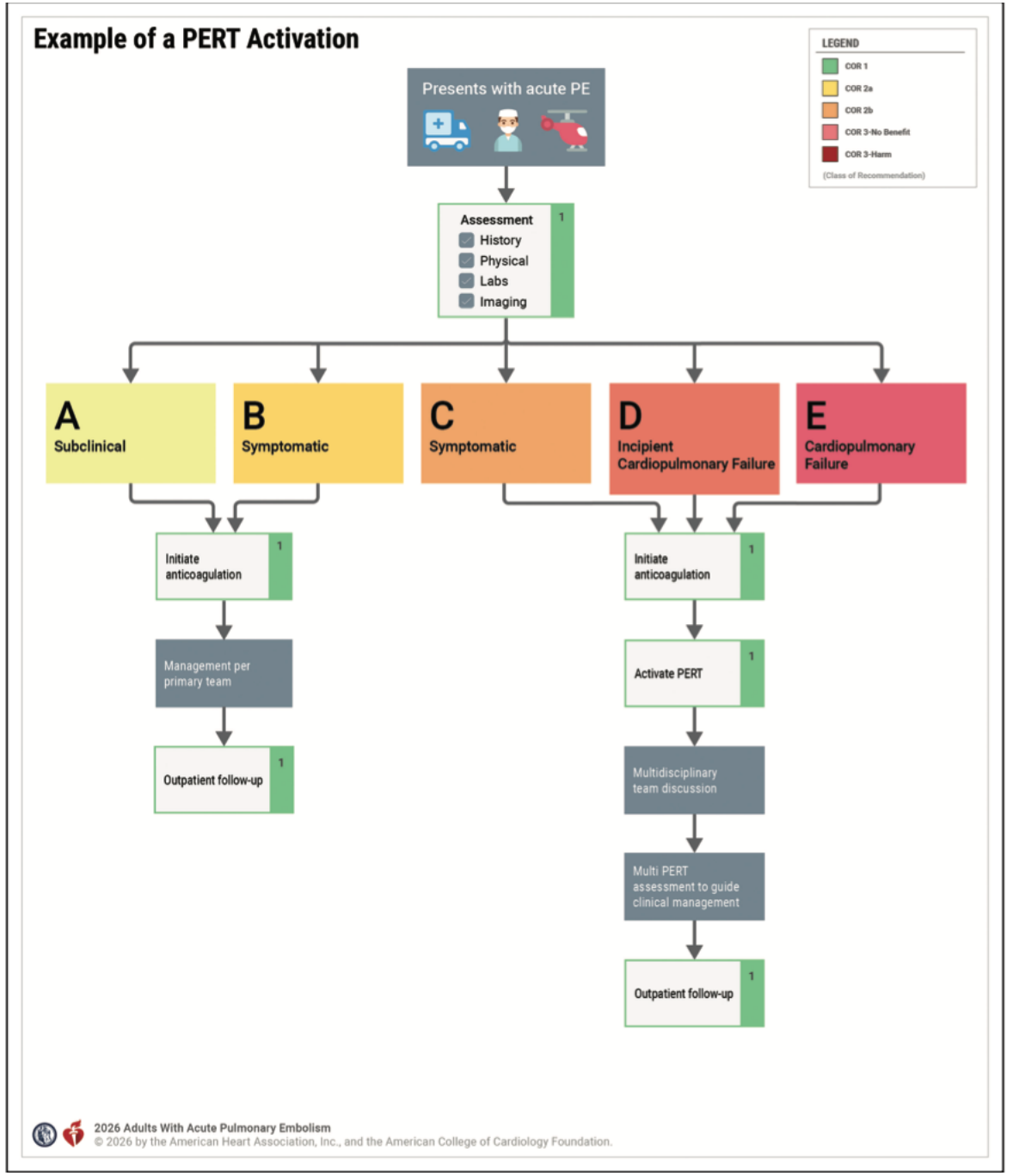
Recommendations for Surgical Embolectomy (Continued)		
COR	**LOE**	**Recommendations**
3: No Benefit	**C-EO**	4. In patients with acute PE in AHA/ACC PE Categories A-C3, surgical embolectomy is not recommended over anticoagulation alone for improving clinical outcomes or symptoms.
3: No Benefit	**B-NR**	5. In patients with acute PE in AHA/ACC PE Category E2 not on mechanical circulatory support, surgical embolectomy is not recommended over other advanced therapies for preventing short-term mortality.[9]

RV clot in transit

Recommendations for Interventional Advanced Management Referenced studies that support recommendations are summarized in the Evidence Table.		
COR	**LOE**	**Recommendations**
2a	**C-LD**	1. In patients with acute PE in AHA/ACC PE Categories C3-E2 who have evidence of free-floating right atrial and/or RV clot-in-transit, the utilization of advanced therapies over anticoagulation alone is reasonable to reduce the risk of clinical deterioration.[1]

Pulmonary Embolism Response Team PERT

Recommendation for PERT Referenced studies that support the recommendation are summarized in the Evidence Table.		
COR	**LOE**	**Recommendations**
1	**B-NR**	1. In patients with acute PE who are at increased risk of adverse outcomes (ie, AHA/ACC PE Categories C-E)*, a multidisciplinary PERT assessment is recommended to improve in-hospital clinical care delivery.[1–18]



Role of the Inferior Vena Cava Filter

- In patients with acute PE who *cannot tolerate anti coagulation*, IVC filters can be useful to reduce the short-term incidence of recurrent PE

- In patients with acute PE who cannot tolerate anticoagulation but in whom an IVC filter is deemed necessary, *retrievable IVC filters are recommended over permanent filters* to reduce the short-term incidence of recurrent PE while minimizing long term adverse outcomes
- In patients with *recurrent PE despite optimal therapeutic anticoagulation* who are in AHA/ACC PE Categories B-E, IVC filter placement may be considered to reduce the short-term incidence of additional recurrent PE

- In patients with acute PE who are therapeutically anticoagulated,

Inhaled pulmonary vasodilators

Recommendations for Hemodynamic Pharmacotherapy (Continued)		
COR	LOE	Recommendations
2b	B-R	3. For patients with acute PE in AHA/ACC PE Categories C2-E, the use of inhaled pulmonary vasodilators may be considered to reduce RV afterload.[6–8]

A recent multicenter RCT evaluated inhaled nitric oxide in normotensive patients with acute PE and RV dysfunction.

Although inhaled nitric oxide did not improve the primary composite outcome (normalization of troponin and echocardiographic findings at 24 hours), a post-hoc analysis showed a significant improvement in RV size and function at 24 hours

In contrast, small, randomized trials of nonselective vasodilators such as oral sildenafil and intravenous epoprostenol have shown minimal or no benefit on primary clinical

Category C Treatment: Restraint is Key



- HARM > BENEFIT! Systemic thrombolysis should NOT be used in C1-C2 (Class 3: Harm).
- CDL (Catheter-Directed Thrombolysis) is NOT recommended over anticoagulation alone in C1-C2 (Class 3: No Benefit).
- For C3 patients, the benefit of Systemic Thrombolysis or CDL over anticoagulation alone remains uncertain (Class 2b).

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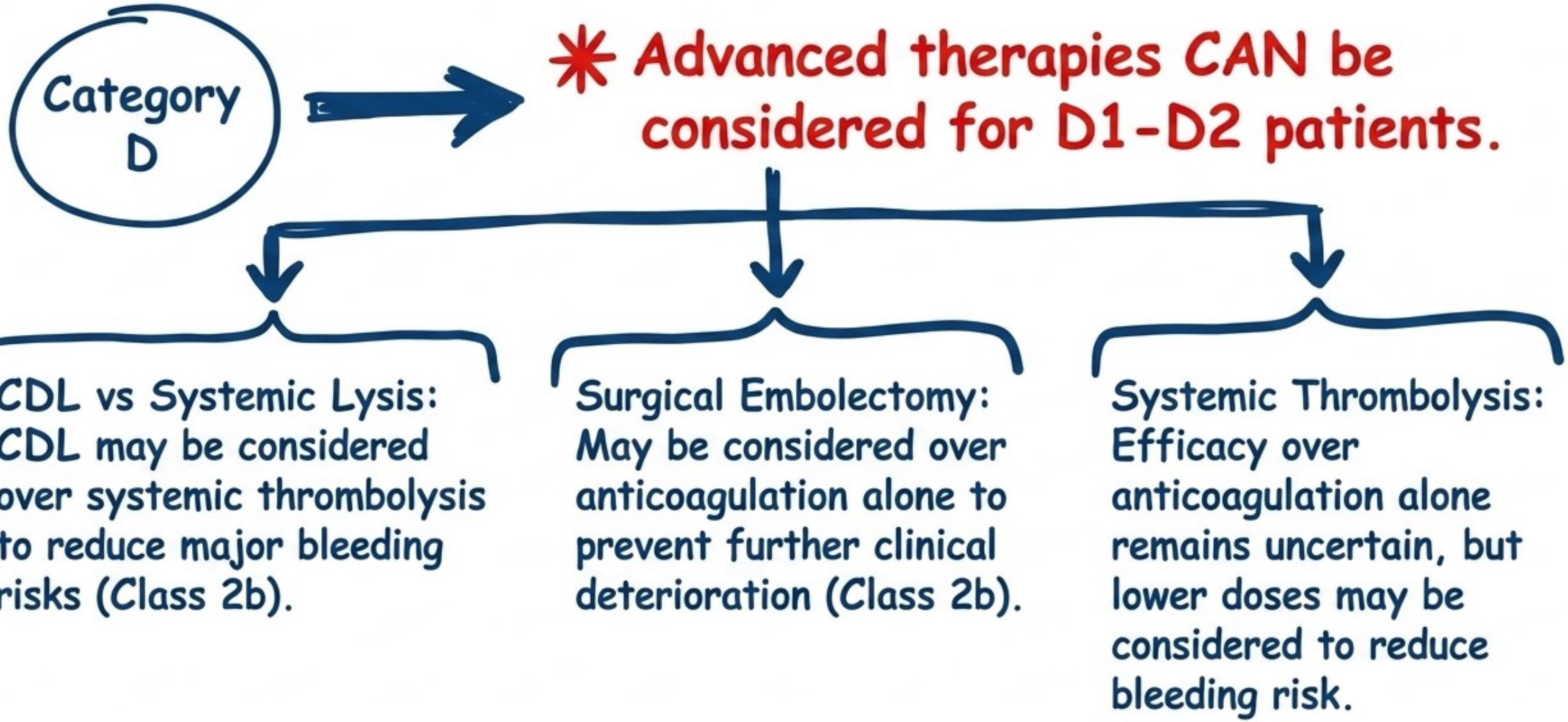
Category D Treatment: The Window for Advanced Therapy



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Category E Treatment: Immediate Advanced Measures

- VA-ECMO: Reasonable to institute in E2 (refractory shock/arrest) to stabilize hemodynamics and improve oxygenation (Class 2a).
- Continue Systemic Anticoagulation: Must continue even on ECMO (in the absence of bleeding).
- Interventional Clot Removal: Utilization of advanced therapies over anticoagulation alone is reasonable (Class 2a). CDL may be considered over systemic lysis to reduce bleeding.



DO NOT TRANSFER: Category E patients should not be transferred to another medical center before stabilizing their condition.

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Master Interventions Matrix

	Category C	Category D	Category E
Systemic Anticoagulation	Standard	Standard	Standard
Systemic Thrombolysis	Harmful (C1-C2) Uncertain (C3)	Can be considered	Reasonable
Catheter-Directed (CDL)	No Benefit (C1) Uncertain (C3)	Can be considered	Reasonable
VA-ECMO	Not Indicated	Not Indicated	Reasonable (E2)

Gemini Notebook

Interhospital Transfers

- Decisions regarding transfer must be tailored to each patient's needs, ensuring timely access to appropriate care for optimal outcomes

- Immediate stabilization prior to transfer is crucial, and potentially lifesaving interventions that are widely available, such as intravenous

Recommendations for Interhospital Transfers
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	Recommendations
2b	C-LD	1. For patients with acute PE who exhibit high-risk features* but are hemodynamically stable (AHA/ACC PE Categories C3-D), transferring to a center that can provide advanced therapies† may be considered to ensure access to appropriate interventions.[1]
3: Harm	C-EO	2. Unstable patients with acute PE (AHA/ACC PE Category E) should not be transferred to another medical center before stabilizing their condition.

Post-Acute PE Management

Anticoagulation Therapy by Recurrence Risk

- In patients with a first acute PE *due to a major reversible risk factor*, stopping anticoagulation at the end of the initial treatment phase (3-6 months) is recommended over continuing anticoagulation into the extended treatment phase in order to optimize the net clinical benefit of recurrent VTE versus bleeding.**1B**

- In patients with a first acute PE and *no major reversible risk factor*, continuing anticoagulation beyond the initial treatment phase (3-6 months) into the *extended treatment phase* is beneficial to prevent recurrent VTE **1A**

- In patients with a first PE due to a *persistent risk factor*, continuing anticoagulation at the initial treatment phase (3-6 months) into the extended treatment phase is reasonable in order to prevent recurrent VTE.**1C**

DOAC vs VKA

For patients with a PE who are offered anti-coagulation beyond the initial treatment phase (3-6 months) into the extended treatment phase, treatment with a **DOAC**, unless contraindicated, *is recommended* over a VKA to reduce the risk of bleeding **1A**

- RCT of >8200 patients, edoxaban, when compared with warfarin, was associated with a similar risk of recurrent VTE, with a lower risk of clinically relevant bleeding than warfarin.
- retrospective studies and a meta-analysis of >62 000 patients have suggested that risk of bleeding is lower with a DOAC than with warfarin

For patients with a PE and with **cancer** who are offered anticoagulation beyond the initial treatment phase (3-6 months) into the extended treatment phase, either a **DOAC or LMWH** is recommended over VKA to reduce the risk of recurrent VTE

Low dose AC

For patients with a PE who are offered anticoagulation beyond the initial treatment phase (3-6 months) into the **extended treatment phase**, treatment with **half-dose** apixaban or rivaroxaban is recommended to reduce the risk of bleeding

RENOVE (Reduced Dose Versus Full-Dose of Direct Oral Anticoagulant After Unprovoked Venous Thromboembolism) trial, 2768 patients. The overall rates of VTE were low in all groups

API-CAT (Apixaban Cancer-Associated Thrombosis Trial), 1766 patients with cancer-associated VTE were randomized to apixaban 2.5 mg or 5 mg twice daily after at least 6 months of treatment. The rate of recurrent VTE was similar in both groups

half-dose DOAC can be safe and effective even in patients at high risk for VTE recurrence and bleeding

Aspirin?

For patients who would be offered anticoagulation beyond the initial treatment phase (3-6 months) into the extended treatment phase, but have a *contraindication to or refuse anticoagulation*, it is *reasonable to* choose low-dose aspirin over no therapy to reduce the risk of recurrent VTE. **2A**

Patient Activity and Travel

Recommendations for Patient Activity and Travel
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	Recommendations
2a	A	1. In patients recovering from acute PE, it is reasonable to encourage early ambulation rather than bed rest in order to reduce the risk of complications.[1]
2a	B-R	2. In patients with a history of acute PE, use of compression stockings during long-haul (≥5 h) travel can be useful to lower the risk of DVT.[2,3]
2b	C-EO	3. In patients with a history of acute PE related to travel or immobility who are not currently receiving anticoagulation therapy, it may be reasonable to use a one-time prophylactic dose of an oral anticoagulant or a parenteral LMWH on the day of long-haul travel to reduce the risk of recurrent VTE.
2b	C-LD	4. For patients recovering from acute PE in AHA/ACC PE Categories C2-E, it may be reasonable to restrict long-haul travel for 4 weeks after initiation of treatment or when symptoms have resolved to reduce risk of adverse events.[1]

MONITORING AND FOLLOW-UP

Recommendations for Follow-Up Care for Acute PE
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	Recommendations
1	C-LD	1. In patients with acute PE, it is beneficial to have clinical follow-up within the first week of discharge to provide patient education, address barriers to anticoagulation therapy, ensure adherence to prescribed medications, and detect bleeding complications.[1–3]
1	C-EO	2. Patients with acute PE should have a clinical visit at or before 3 months after diagnosis to discuss duration of anticoagulation, review the need for further testing, and assess for persistent PE-related symptoms.
1	C-LD	3. Patients who have had acute PE should be asked about PE-related symptoms and functional limitations at every visit for at least 1 year to screen for CTEPD or other causes of dyspnea and functional limitation.[4,5–8]

Cancer Screening and Thrombophilia Testing in the Absence of PE Risk Factors

- In patients with acute PE, cancer is diagnosed in 4% to 10% during the first year when no major reversible risk factors for PE are identified
- The incidence of cancer increases with age
- Almost half of cancers are diagnosed through a thorough medical history and physical examination. Therefore, performing a comprehensive medical history, physical examination, and ***age- appropriate cancer screening*** in accordance with national guidelines remains an appropriate strategy to identify undetected cancers
- In patients with acute PE, ***routine*** imaging with CT or positron emission tomography-CT is ***not recommended*** to diagnose undetected cancer

Thrombophilia Testing

- In cases where no clearly provoking factor for PE can be identified, testing for hereditary thrombophilia *does not significantly alter the duration* of the patient's anticoagulant treatment
- Isolated heterozygosity for common genetic mutations (eg, factor V Leiden, prothrombin gen mutation) are not consistently associated with increased risk of recurrence
- Deficiencies in natural anticoagulants (antithrombin, protein C, protein S) are linked to a higher risk of recurrence and may necessitate extended anticoagulation. These thrombophilias are infrequent but tend to manifest at an earlier age and often coincide with a family history of thrombosis
- In patients without a major reversible risk factor for acute PE who *have a family history of thrombosis or are <55 years of age, it might be reasonable* to perform testing for genetic and acquired thrombophilia if the thrombophilia tests results are anticipated to change management or better inform family risk

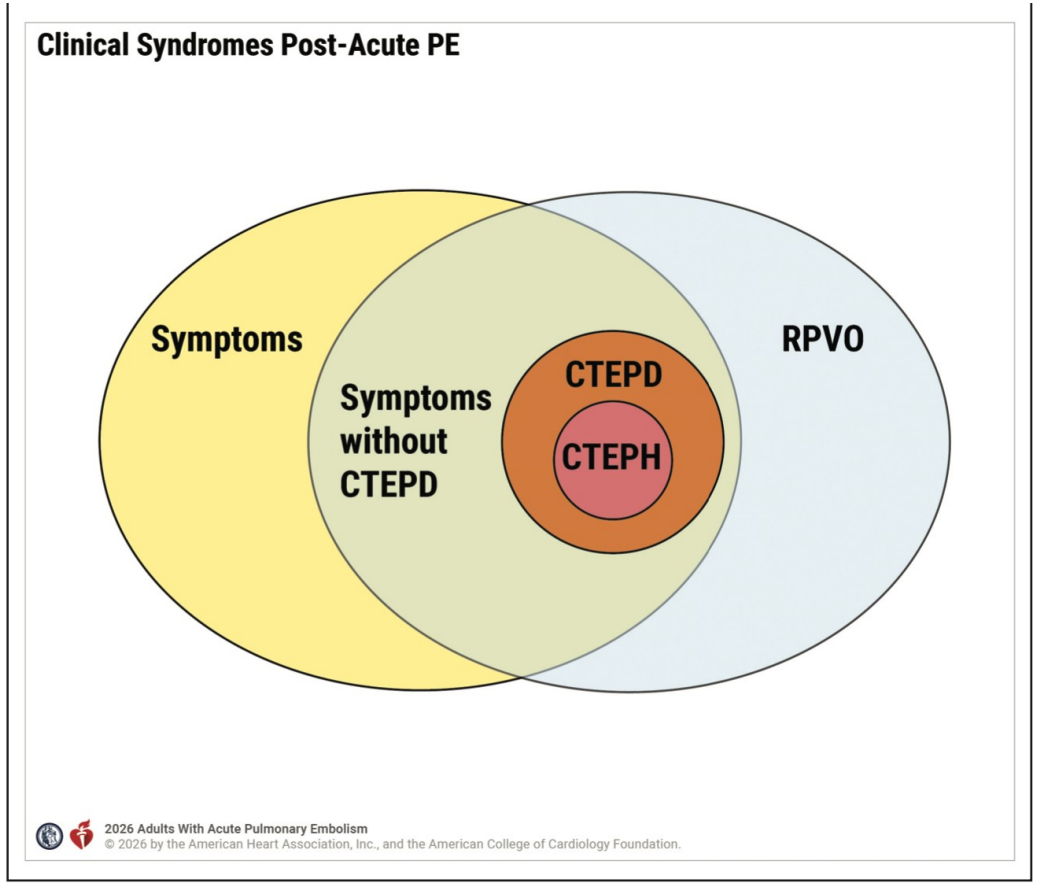
Follow-Up Care for Acute PE

- In patients with a history of acute PE who remain on anticoagulation into the extended phase (beyond 3-6 months from diagnosis), periodic reassessment of the risk and benefits of continued anticoagulation is recommended to ensure the safety and efficacy of continuing anticoagulation

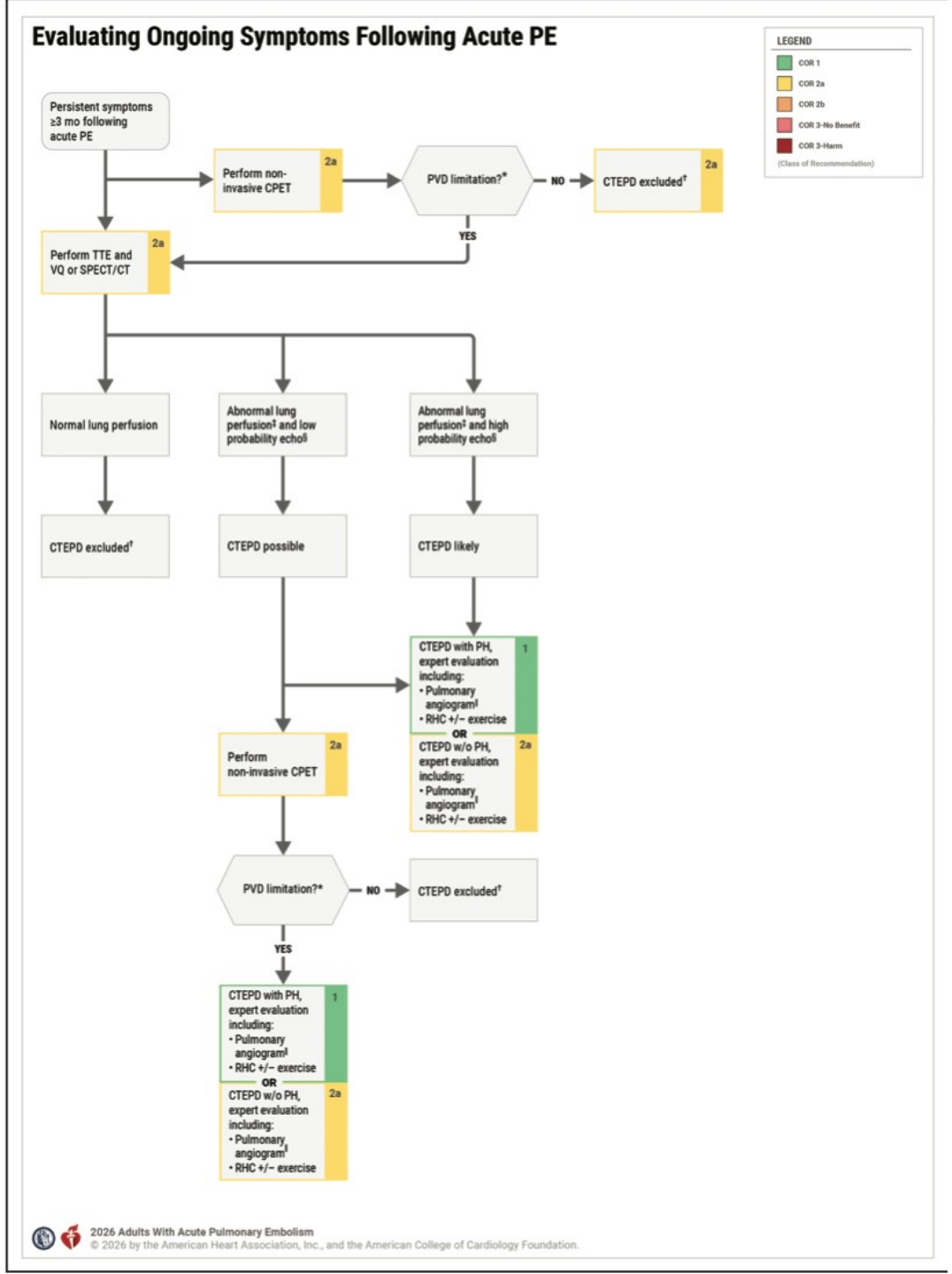
- *In patients who remain symptomatic* 3 to 6 months after acute PE, it may be reasonable to obtain a performance test (*six-minute walk test*, incremental shuttle walk test, endurance shuttle walk test) to quantify physical limitations and identify which patients require more extensive evaluation.
- CTEPD with PH complicates 2.3% to 4% of acute PEs

Persistently Symptomatic Patients After Acute PE

- Up to **half** of patients after an acute PE will have **ongoing dyspnea** and/or functional impairment despite 3 months of therapeutic anticoagulation.
- About **half** of patients with acute PE have persistent perfusion defects on imaging, termed residual pulmonary vascular obstruction **(RPVO)**, many of whom are asymptomatic
- CTEPD encompasses patients who had a PE and have persistent symptoms, RPVO, and pulmonary vascular disease related exercise limitation, both without and with resting PH.
- The prevalence of CTEPD with PH, also called chronic (CTEPH), after acute PE is approximately 3%.



Evaluating Ongoing Symptoms Following Acute PE



Persistently Symptomatic Patients After Acute PE

In patients with ongoing dyspnea and/or functional impairment after ≥3 months of therapeutic anticoagulation after an acute PE, a diagnostic evaluation is recommended to assess for CTEPD.**1B**

- reduced the time to diagnosis of CTEPD with PH
- waiting longer only delays the diagnosis

- For patients undergoing a diagnostic evaluation for CTEPD, it is reasonable to obtain both a *transthoracic echocardiogram* (TTE) and a *lung perfusion Scan* to exclude CTEPD or determine if additional diagnostic testing is needed
- The negative predictive value of planar V/Q to exclude a

Persistently Symptomatic Patients After Acute PE

- For patients undergoing a diagnostic evaluation for CTEPD, cardiopulmonary exercise testing (CPET) is reasonable to exclude CTEPD

- In patients with a history of acute PE, who have resolution of symptoms and low suspicion for CTEPD, a follow-up CTPA or lung perfusion scan (planar V/Q, V/Q SPECT, SPECT/CT) is not beneficial to assess for the degree of thrombosis resolution. **3: No benefit**

Questions

Thank you