

Pulmonary Embolism Clinical Pathway

Dyspnea
Tachypnea
Pleuritic CP
Palpitations
Hemoptysis
Syncope
Leg pain or edema
Pulmonary rales, localized wheezing, decreased breath sounds
Tachycardia in 30-50%, also may be bradycardic

Determine Well's score (appendix A)
< 2 is low risk of PE
2-6 is intermediate risk
> 6 is high risk

Revised Geneva Score (appendix C)
0-3 is low risk of PE
4-10 intermediate risk
11-22 high probability

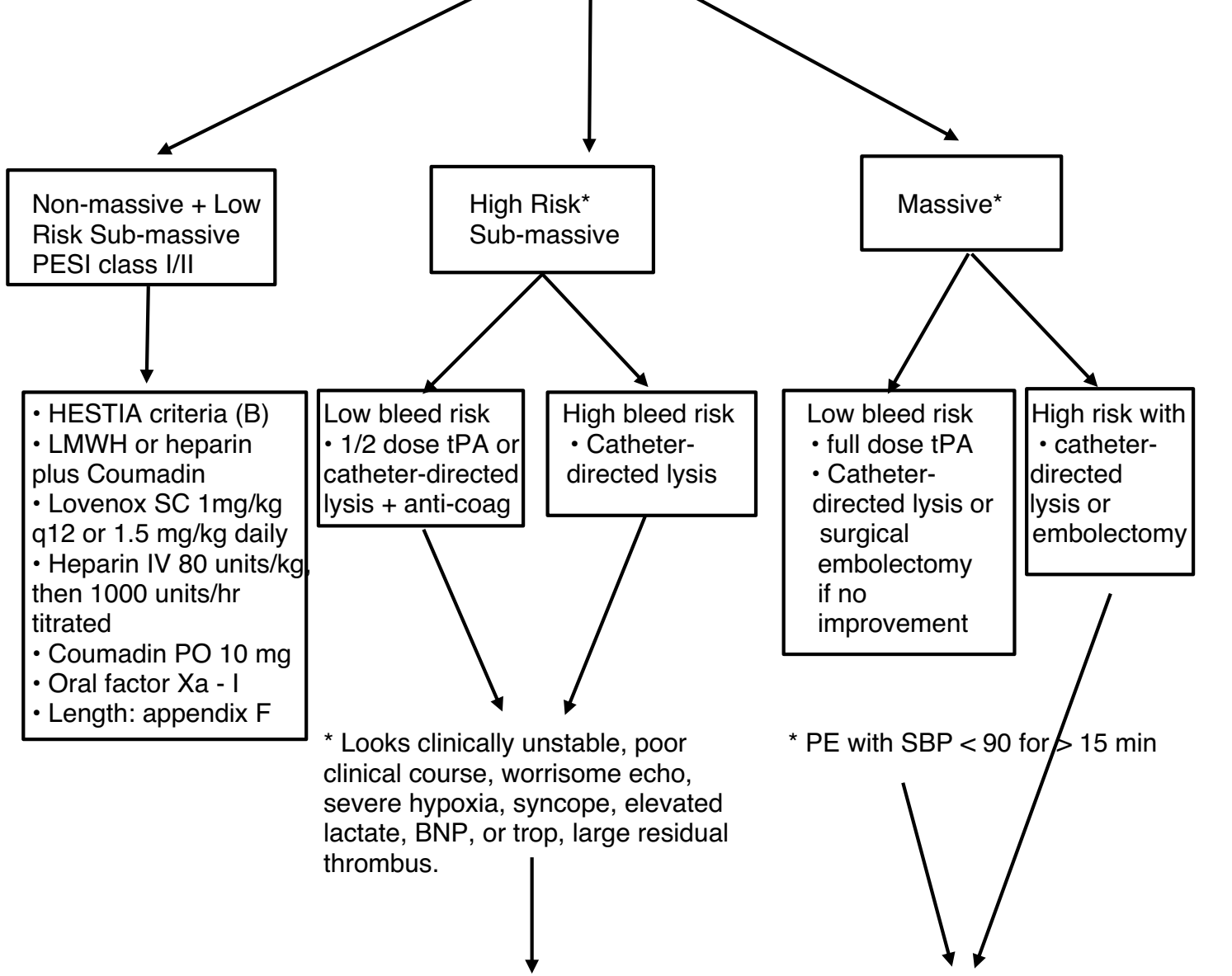
Low risk --> D-dimer
• Negative result excludes
• If d-dimer expected to be elevated from another condition, consider R/O differential dx ie. CXR for PNA, EKG for ACS
• Positive D-dimer --> CT, VQ scan, lower extremity ultrasound

Intermediate or high risk --> D-dimer not recommended
• CT or VQ scan can be definitive
• DVT on LE ultrasound can rule in, but not out

Suspected PE in patients with shock or hypotension
• Echo may show pulmonary HTN and R vent overload
• Telemetry may show R. heart strain pattern (S1Q3T3) or pulmonary HTN pattern (T wave inversions V1-V3, esp if concurrently present in inferior leads)
• Pulmonary angiography NOT recommended
• CT only for stabilized patient

Calculate PESI score for PE (appendix D)





Other management strategies in high risk sub-massive and massive PE

- Volume loading can actually worsen R ventricular dilation. If concurrent hypovolemia suspected, bolus in small, discrete amounts (ie. 500 cc) with close monitoring
- Early vasopressor use recommended. Norepinephrine or epinephrine are agents of choice
- Inhaled nitric oxide causes pulmonary vasodilation and improves oxygenation, but expensive (we don't carry)
- Avoid or delay intubation. PE patients usually die of hemodynamic collapse, NOT ventilatory failure. Intubation usually worsens hemodynamic picture.
- Early thrombolysis (Appendix F), determine contraindications ASAP (Appendix E)
- Cardiac arrest patients: consider "code dose" alteplase 50 mg IV bolus and epinephrine. Small retrospective studies have suggested earlier tPA dosing, rather than "last resort" dosing after arrest, associated with ROSC and improved survival to discharge.

Appendix A: Well's Score

Medscape®		www.medscape.com	
Variable	Points		
Clinical signs and symptoms of DVT*	3.0		
An alternative diagnosis is less likely than PE	3.0		
Heart rate >100 beats per minute	1.5		
Immobilization or surgery in previous 4 weeks	1.5		
Previous DVT/PE	1.5		
Hemoptysis	1.0		
Malignancy (on treatment, treated in the last 6 mos or palliative)	1.0		

**Minimum of leg swelling and pain with palpation of deep veins; DVT, deep-vein thrombosis; PE, pulmonary embolism*

Score	Category	Score	Category
<2 points	low probability	<4 points	unlikely PE
2–6 points	moderate probability	≥4 points	likely PE
>6 points	high probability		

Source: Lab Med © 2008 American Society for Clinical Pathology

Appendix B: HESTIA criteria

Table 1 Hestia criteria

Hestia criteria

1. Hemodynamically unstable?*
2. Thrombolysis or embolectomy necessary?
3. Active bleeding or high risk of bleeding?†
4. Oxygen supply to maintain oxygen saturation > 90% > 24 h?
5. Pulmonary embolism diagnosed during anticoagulant treatment?
6. Intravenous pain medication > 24 h?
7. Medical or social reason for treatment in the hospital > 24 h?
8. Creatinine clearance of less than 30 mL/min?‡
9. Severe liver impairment?§
10. Pregnant?
11. Documented history of heparin-induced thrombocytopenia?

If one of the questions is answered with **YES**,

The patient can **NOT** be treated at home

Table 2. The Revised Geneva Score*

Variable	Regression Coefficients	Points
Risk factors		
Age > 65 y	0.39	1
Previous DVT or PE	1.05	3
Surgery (under general anesthesia) or fracture (of the lower limbs) within 1 mo	0.78	2
Active malignant condition (solid or hematologic malignant condition, currently active or considered cured < 1 y)	0.45	2
Symptoms		
Unilateral lower-limb pain	0.97	3
Hemoptysis	0.74	2
Clinical signs		
Heart rate		
75–94 beats/min	1.20	3
≥95 beats/min	0.67	5
Pain on lower-limb deep venous palpation and unilateral edema	1.34	4
Clinical probability		
Low		0–3 total
Intermediate		4–10 total
High		≥11 total

* DVT = deep venous thrombosis; PE = pulmonary embolism.

Pulmonary Embolism Severity Index

Predictors	Points
Age	+1 per year
Male sex	+10
Heart failure	+10
Chronic lung disease	+10
Arterial oxygen saturation <90%	+20
Pulse ≥ 110 beats per minute	+20
Respiratory rate ≥ 30 breaths per minute	+20
Temperature <36°C	+20
Cancer	+30
Systolic blood pressure <100 mm Hg	+30
Altered mental status	+60

Pulmonary Embolism

Severity Score (Sum of the Points)	Risk Class	30-day Mortality Rate
≤ 65	I	0–1.6%
66–85	II	1.7%–3.5%
86–105	III	3.2%–7.1%
106–125	IV	4.0%–11.4%
>125	V	10.0%–24.5%

Appendix E

Table 13. Contraindications To Thrombolytic Therapy For Acute Pulmonary Embolism.

Absolute

- Previous history of hemorrhagic stroke at any time
- Known intracranial neoplasm
- Recent (< 1 month) intracranial surgery or trauma
- Active internal bleeding (does not include menses)

Relative

- Known bleeding diathesis, including thrombocytopenia
- Uncontrolled severe hypertension (blood pressure > 180/110 mmHg)
- History of previous nonhemorrhagic stroke
- Recent (< 1 month) surgery or trauma
- Noncompressible vascular puncture
- For urokinase or streptokinase, prior exposure

Source: Stein PD, Henry JW, Relyea B. Untreated patients with pulmonary embolism. Outcome, clinical, and laboratory assessment. *Chest* 1995 Apr;107(4):931-935.

Appendix F

Table 1. Thrombolytic Agents

Agent	FDA-Approved Indications	IV Dosing	Comments
Alteplase (rt-PA)	AIS	0.1 mg/kg bolus, then: 0.8 mg/kg infusion over 60 min	ICH: 0.4%-0.9% Max dose = 90 mg (AIS)
	Acute PE	100 mg infusion over 2 h	Fibrin specific
	STEMI	>67 kg: 100 mg IV (total) 15 mg bolus over 1-2 min 50 mg over 30 min 35 mg over 60 min ≤67 kg: 100 mg IV (max) 15 mg bolus over 1-2 min 0.75 mg/kg over 30 min (max 50 mg) 0.5 mg/kg over 60 min (max 35 mg)	Fibrinogen sparing
Retepase	STEMI	10 units IV push over 2 min Repeat in 30 min	Anaphylaxis ICH: 0.8%
Streptokinase	STEMI	1.5 million units over 60 min	Anaphylaxis
	Acute PE/DVT	250,000 IU IV over 30 min, then: 100,000 IU/h for 24 h (PE) or 72 h (DVT)	ICH not reported
Tenecteplase	STEMI	<60 kg: 30 mg IV bolus 60-69 kg: 35 mg IV bolus 70-79 kg: 40 mg IV bolus 80-89 kg: 45 mg IV bolus >90 kg: 50 mg IV bolus	IV push over 5 sec Most fibrin specific Fibrinogen sparing ICH: 0.9%
Urokinase	Acute PE	4,400 IU/kg over 10 min bolus, then: 4,400 IU/kg/h IV for 12 h	Anaphylaxis ICH: <1%

AIS: acute ischemic stroke; DVT: deep venous thrombosis; ICH: intracerebral hemorrhage; IU: international units; max: maximum; min: minute; PE: pulmonary embolism; rt-PA: recombinant tissue plasminogen activator; sec: second; STEMI: ST-segment elevation myocardial infarction.
Source: References 1, 6-12.

Appendix G: Length of anticoagulation therapy

Transient risk factor for PE present	3 months
Unprovoked PE	Extended
Active cancer	Extended

- Boulain T, Lanotte, R., Legras, A., and Perrotin. (1993, July). Efficacy of epinephrine therapy in shock complicating pulmonary embolism. *Chest* 104(1):300-302.
- Grifoni S, et al. (2000, June). Short-term clinical outcome of patients with acute pulmonary embolism, normal blood pressure, and echocardiographic right ventricular dysfunction. *Circulation* 101(24) 2817-22
- Er, F., et al. (2009, Dec). Impact of rescue fibrinolysis during cardiopulmonary resuscitation in patients with pulmonary embolism. PLOS doi: 10.1371/journal.pone.0008323.
- Janata K, et al. (2003, April). Major bleeding complications and cardiopulmonary resuscitation: the place of thrombolytic therapy in cardiac arrest due to massive pulmonary embolism. *Resuscitation* 57(1):49-55.
- Sharifi M., et al. (2013, Jan). Moderate pulmonary embolism treated with thrombolysis. *J Cardiol* doi: 10.1016/j.amjcard.2012.09.027.
- Smulders YM. (2000, Oct). Pathophysiology and treatment of hemodynamic instability in acute pulmonary embolism: the pivotal role of pulmonary vasoconstriction. *Cardiovasc* 48(1):23-33
- Ternacle J, et al. (2013). Diuretics in normotensive patients with acute pulmonary embolism and right ventricular dilation. *Circ J* 77(10):2612-8
- Ventetuolo CE and Klinger JR. (2014, June). Management of acute right ventricular failure in the intensive care unit. *Ann Am Thorac Soc* 11(5):811-22
- Zhang, Z., et al. (2014 March). Lower dosage of recombinant tissue type plasminogen activator in the treatment of acute pulmonary embolism: A systematic review and meta-analysis. *Thrombosis Research* doi: 10.1016/j.thromres.2013.12.026.