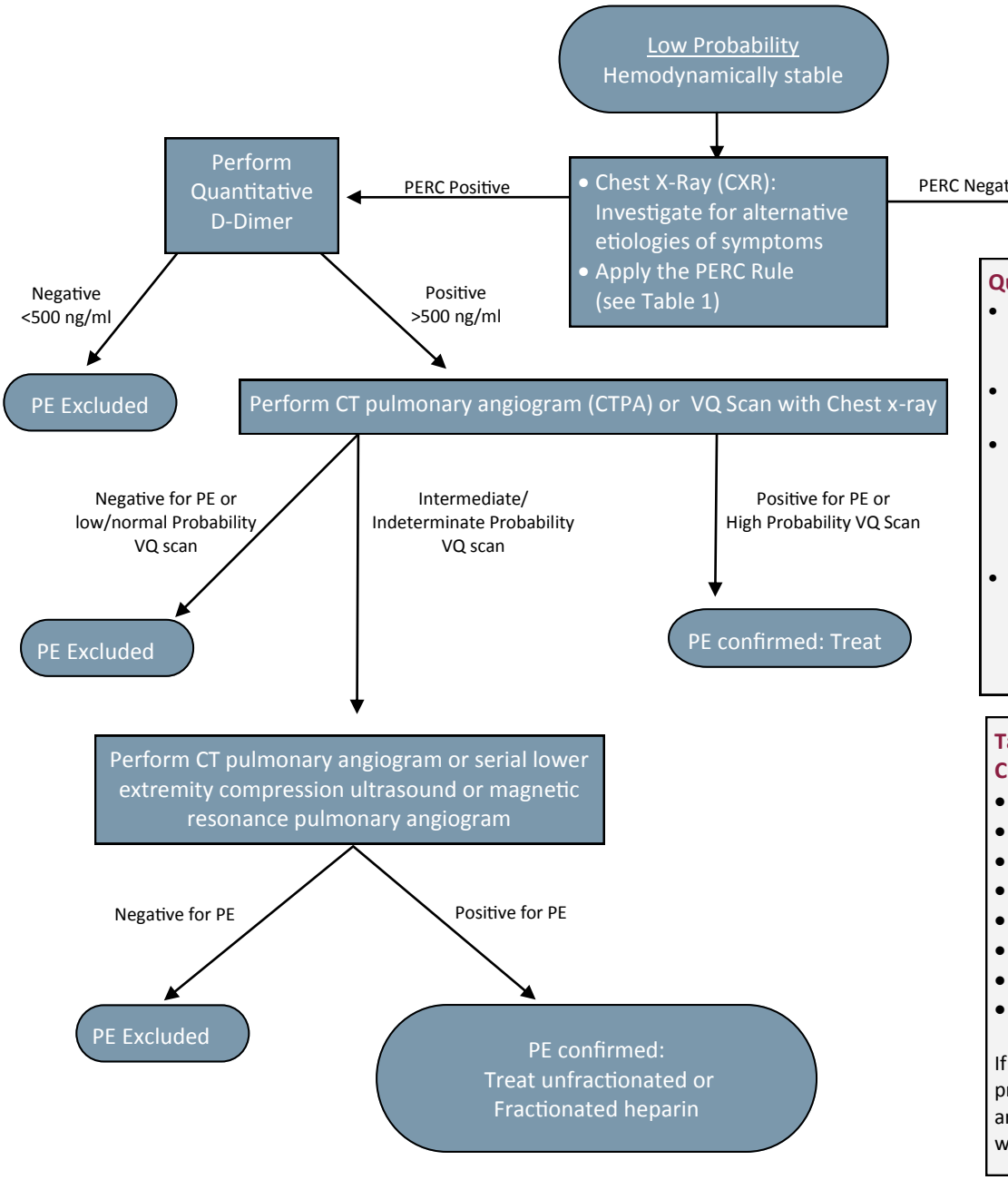
MOUNT CARMEL Health Partners

Recommendation for the Evaluation and Treatment of Pulmonary Embolus

Definition: Pulmonary embolism (PE) is a thrombus, usually originating in a lower extremity vein, that embolizes to the pulmonary arterial circulation. Depending on the size, location and hemodynamic effects, a pulmonary embolus can have minor, catastrophic or lethal consequences. The majority of pulmonary emboli are undiagnosed ante-mortem.

Patients present with seemingly typical exacerbations of chronic disease processes such as COPD, asthma or bronchitis which may mask symptoms of undiagnosed PE. The diagnosis of a PE can be difficult because the signs and symptoms are often nonspecific and subtle. Risk stratification for the pre-test probability or likelihood of pulmonary embolism is useful in guiding diagnostic testing and algorithms can assist in decision-making. Patient being evaluated for a PE must be determined to be at either low risk for PE or at moderate to high risk. The PERC algorithm i.e., "Pulmonary Embolus Rule-Out Criteria" can be applied to low risk patients. Patient's with a low pretest probability can be safely ruled out for a PE with these decision rules or if testing with a negative d-dimer test. Patients with high pretest probability however, and a negative D-dimer cannot be ruled out because of negative predictive value of the D-dimer assay is not sufficient to rule-out a PE. Patients at risk should undergo CT pulmonary angiography or Ventilation/perfusion Scan (VQ Scan).



Quick Guide

- Pulmonary embolus can be a diagnostic challenge because of its protean presentations
- Risk stratification at presentation should guide management
- Besides conventional anticoagulation, higher-risk patients maybe candidate for adjunctive therapies; surgical embolectomy, thrombolysis, or Ekos to optimize their outcome
- Contraindication to CT angiogram (CTA): Glomerular Filtration Rate (GFR) < 60ml/ min/1.73m^2 or contrast allergy or morbid obesity

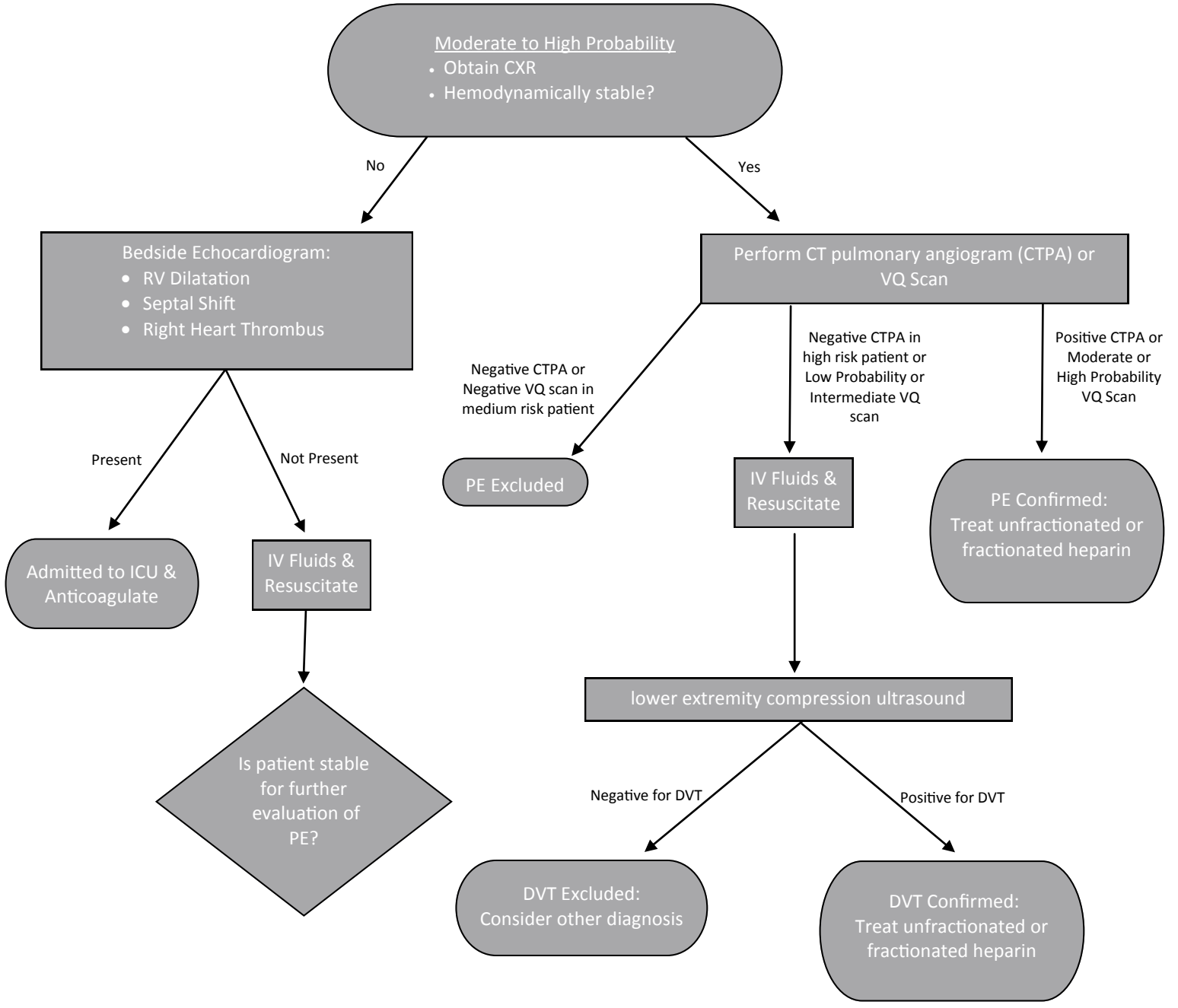
Table 1: Pulmonary Embolism Rule-out Criteria (PERC):

- Age ≥ 50 years?
- Heart Rate ≥ 100 bpm?
- O2 Saturation on Room Air < 95%?
- Prior History of DVT/PE
- Recent Trauma or Surgery?
- Hemoptysis?
- Exogenous Estrogen?
- Unilateral Leg Swelling?

If no to all criteria and with clinician's pre-test probability < 15%, PERC Rule criteria are satisfied and no further workup needed with <2% probability of PE.

The main benefit of performing a Chest x-ray in evaluating a patient for suspected pulmonary embolism is to evaluate for alternative cause of symptoms such as pneumothorax. While chest x-rays are normal up to twenty-five percent of patients, indirect findings of a pulmonary embolus include Fleischner sign; distended central pulmonary artery due to presence of a large clot, Westermark Sign; oligemia distal to the embolism, Hamptom hump; wedge-shaped consolidation of the involved lung tissue reflecting pulmonary infarct or Fleischner lines, which are long bands of focal atelectasis seen in pulmonary infarcts.

CT pulmonary angiography with a sensitivity of 83% and a specificity of 96% is commonly used to evaluate patients at high risk for pulmonary embolism showing no signs or symptoms of PE, may not warrant further testing per the clinical decision rule and the disease can be safely excluded with lower extremity compression ultrasound.



Pregnant females are physiologically hypercoagulable making them five to ten times more likely to form a thrombus. The classic signs and symptoms of a pulmonary embolism such as dyspnea, tachycardia and lower extremity edema are seen normally during pregnancy. This results in unreliable risk stratification algorithms which cannot be accurately applied to pregnant patients. D-dimer fluctuates during pregnancy and false positive results are common in pregnancy. D-dimer is typically normal during the first trimester, rises during the second trimester and decreases after delivery reaching normal levels at four to six weeks postpartum. However, negative d-dimer has been useful in ruling out a pulmonary embolus in pregnant and postpartum patients.

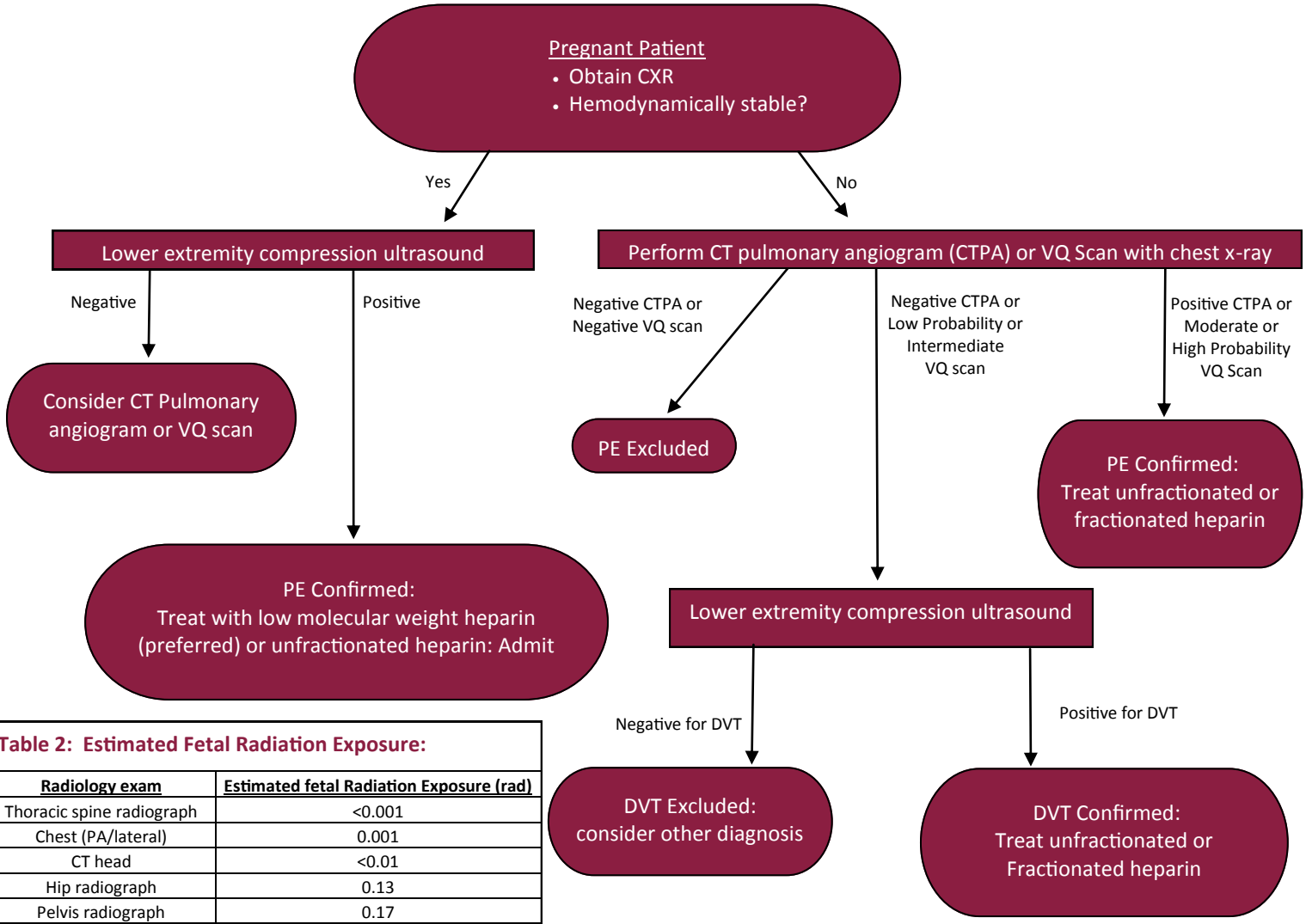


Table 2: Estimated Fetal Radiation Exposure:

Radiology exam	Estimated fetal Radiation Exposure (rad)
Thoracic spine radiograph	<0.001
Chest (PA/lateral)	0.001
CT head	<0.01
Hip radiograph	0.13
Pelvis radiograph	0.17
abdominal radiograph	0.24
lumbar spine radiograph	0.34
CT abdomen/pelvis	1-2
Ventilation Perfusion Scan	0.06 - 1.0
CT chest Angiogram	2 - 4
VQ Scan	37-54 mrads

Microcephaly, Mental Retardation thought to arise after 10-20 rad exposure

Anomalies, IUGR, miscarriage rare<5 rads

Creasy RK,Resnik R, et al maternal-fetal medicine principles and practice 6th edition

The radiation dose to the fetus during a ventilation-perfusion scan (V/Q scan) has been estimated to be 100-300 mGy and 280 mGy to the mother's breast. Both computed tomography pulmonary angiography (CTPA) and the ventilation/perfusion (V/Q) scan involve exposure to ionizing radiation. The effect of low-level ionizing radiation remains an issue of some controversy. CTPA delivers a greater effective dose and, in particular, greater doses to breast tissue, than the V/Q scan (typically 10-70 mGy for CTPA vs <1.5 mGy for V/Q to breast). Since breast tissue is particularly radiosensitive in younger women, the V/Q study has an advantage over CTPA in this group. In the pregnant patient, fetal exposure has been raised as a concern. In fact, there is typically only low fetal exposure from either study (<1 mGy). The CTPA does deliver less fetal exposure, particularly in the first trimester, but the difference between CTPA and V/Q scan is small when compared with the difference in dose to maternal breast. The oncogenic risk of radiation to the fetus is considered dangerous at 0.01 Gy above background radiation which represents a 0.01% increase in risk of cancer before the age of 20 years. The radiation dose from the combination of a chest x-ray, ventilation-perfusion scan and conventional pulmonary angiogram to the fetus is 0.004 Gy.(2)

Patients with pulmonary embolism presents in a wide variety of ways. Cognitive decision rules such as Wells Criteria assist in determining pretest probability of the diagnosis. Once acute pulmonary embolus is diagnosed, risk stratification can guide patient management. The strata are non-submassive (low risk), submassive (intermediate-risk), or massive (high-risk). Risk stratification can be done quickly on initial presentation to the emergency department by measuring the RV/LV ratio on CT angiogram of the chest. An RV/LV ratio >0.9 indicates that the patient has RV dilation and RV dysfunction consistent with submassive pulmonary embolus. This category confers elevated risk for cardiovascular complications and calls for consideration of treatment options other than just anticoagulation alone. In addition to the CT scan, adjunctive testing can help with risk stratification, including troponin level, BNP level, ECG, and echocardiogram. Massive pulmonary embolus has historically been defined as large central pulmonary emboli with hemodynamic instability with systolic blood pressure <90 despite fluid resuscitation and/or vasopressors, syncope, resuscitated cardiac arrest, or cardiogenic shock. Novel oral agents are rapidly supplanting warfarin as the anticoagulant of choice for these patients.

	Non-Submassive Patient	Submassive Pulmonary Embolus	Massive Pulmonary Embolus
Definition	Normal RV/LV ratio with no evidence of RV dysfunction and normal levels of BNP, troponin, and EKG findings with stable vital signs.	RV/LV ratio on CT scan of greater than 0.9 and/or elevated levels of BNP, troponin, and EKG changes. The combination of an elevated RV/LV ratio and + troponin represents the highest risk submassive patient.	Arterial hypotension with systolic less than 90 despite fluid resuscitation and on vasopressors, syncope, resuscitated cardiac arrest, and cardiogenic shock.
Treatment Recommendations	• Standard forms of initially intravenous and subcutaneous anticoagulation. • Novel oral anticoagulation can be considered in these patients provided they have demonstrated clinic stability with a low risk of bleeding complications.	• Start on either IV unfractionated heparin, Lovenox, or Fondaparinux. • For patients who may be candidates for advanced PE treatment, recommend consideration of IV unfractionated heparin to allow more strict titration of PTT ranges during advanced PE treatment. • Furthermore, given the elevated risk of cardiovascular complications in this subset of PE patients, it is recommended that these patients be considered for advanced pulmonary embolus treatment in the form of ultrasound-facilitated, catheter-based thrombolysis (EKOS—EndoWave Infusion catheter thrombolysis; only FDA-approved catheter directed based thrombolysis system). The review of available data favors and supports the safety and effectiveness of EKOS catheter thrombolysis over IV and has been shown to be superior to standard IV heparin for the treatment of patients with submassive PE. • The protocol for both tPA infusion and heparin nomograms for EKOS catheter thrombolysis have been established within the Mount Carmel System and power plans are in place and approved by Trinity. IVC filter usage in these patients can be considered as adjunctive therapy at the discretion of the vascular interventionalist.	• When considering advance PE therapies in these patients, cross-specialty collaboration is strongly encouraged.
Use of Oral Anticoagulation	Currently recommended oral anticoagulants for venous thromboembolism include warfarin and novel anticoagulant agents. We would defer to individual providers and their societal guidelines on use of oral anticoagulants.		
Documentation	Pulmonary Embolism Admit Power Plan and EKOS for PE Pre- and Post-Procedure.		
Collaboration	Cross-specialty collaboration when advanced PE therapies are being considered is encouraged.		

References

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