Algorithm for PE Diagnosis

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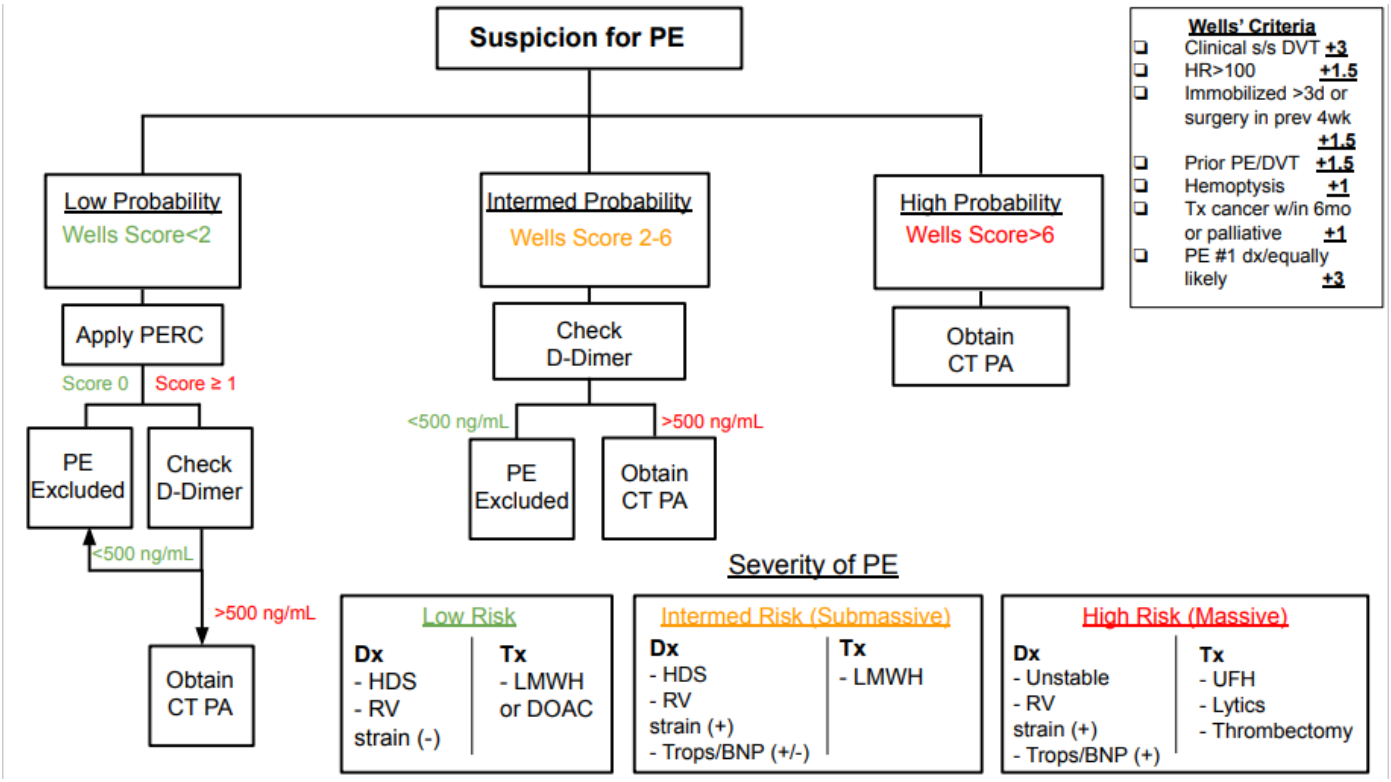

Abbreviations: PE (pulmonary embolism), DVT (deep vein thrombosis), HDS (hemodynamic stability), RV (right ventricle), DOAC (direct oral anticoagulation), LMWH (low molecular weight heparin), UFH (unfractionated heparin), Dx (diagnosis), Tx (treatment), Trops (troponin), HR (heart rate), CTPA (CT pulmonary angiogram)

Definition

- Pulmonary embolism (PE) is a form of venous thromboembolism that causes obstruction in the pulmonary artery or in one of its branches. PE causes infarction, abnormal gas exchange, and could lead to cardiovascular compromise.
- PE can be classified by **temporal presentation** (acute, subacute, chronic), **severity** (low, intermediate, high risk), **location** (saddle, lobar, segmental, subsegmental), and **absence/presence of symptoms** (asymptomatic or symptomatic).

Epidemiology

- In the general population the age adjusted incidence of PE is similar in men and women, but there is a different pattern of incidence for certain age groups. **Women 20- 40 years** have relatively higher rates, whereas **men older than 60 years** have relatively higher rates. The incidence of PE nearly doubles every decade after 40 years old (Jarman et al., 2021).
- Per the CDC, there is an estimated **60,000 to 100,000 deaths annually** due to PE in the United States (CDC 2023).
- A population-based study in *The Am Journal Med* estimates a **30-day and 1-year mortality at 4% and 13%,** respectively (Alotaibi et al., 2016).

Risk Factors

- There are certain inherited (genetic) and acquired risk factors for PE, but the underlying pathogenesis for PE formation is based on Virchow's Triad (venous stasis, endothelial injury, hypercoagulable state).
- Acquired risk factors consists of **provoking** (**recent surgery, immobilization, hormone therapy, malignancy**, etc.) versus non-provoking (obesity, heavy tobacco use, etc.) causes.
- Most common source of emboli come from the **proximal veins of the lower extremities** (iliac, femoral, popliteal).

Manifestations

- Symptoms: two most common are **dyspnea at rest or with exertion** and **pleuritic chest pain**. Some other possible symptoms include cough, calf pain or swelling, or hemoptysis.
- Signs: two most common are **tachypnea** and **calf swelling, tenderness, or redness**. Some other possible signs are tachycardia, rales, diminishes breath sounds, or jugular venous distension.
- Labs: generally nondiagnostic, but two cardiac markers (**NT-proBNP** and **hs-Trop**) can aid in prognostication if PE is ultimately diagnosed. D-Dimer should be obtained based on pre-test probability.
- EKG: two most common findings are **tachycardia** and nonspecific **ST and/or T-wave changes**, but in general EKG abnormalities are largely nonspecific.

Diagnosis

- Definitive diagnosis of PE is confirmed when a **filling defect in any branch of the pulmonary artery** is visualized on CTPA.
- Pre-test probability of PE is calculated by using risk assessment tools (Wells' Score, Geneva Score, or PERC Score) to help determine if further testing is indicated.
- PERC Score is a "rule-out" tool where **all questions must be answered "no"** to be negative.
    - Age >50
    - HR>100
    - O2 sat on RA <95%
    - Unilateral leg swelling
    - Hemoptysis
    - Recent surgery or trauma
    - Prior PE or DVT
    - Hormone use

Treatment

- Mainstay of treatment is **initiating anticoagulation (AC) immediately** once diagnosis is confirmed. The method of AC is determined by the severity of PE:
    - **Low risk**: outpatient treatment with LMWH or DOAC
    - **Intermediate risk**: inpatient treatment with LMWH
    - **High risk**: inpatient treatment with UFH, systemic thrombolytics, and/or reperfusion therapy (embolectomy or ECMO)
- Duration of treatment should be individualized after considering all the following: p**resence or absence of provoking risk factor**s, **risk of bleeding and recurrence**, and the **patient's values**.
- In general, patients with a first episode of PE should be **treated for at least 3 months** and that can extend to 6 or 12 months in select populations.
- Indefinite AC is based on the goal of reducing lifetime risk of recurrence in those who are at high risk for recurrence.

Clinical Pearls

- Utilizing Wells' criteria should always be the first step in determining the pre-test probability for a PE. Although it is a well validated risk assessment tool, it does rely on the clinician's gestalt to determine if other differentials are less likely than a PE.
- PERC criteria should only be applied when there is a low pre-test probability, particularly in ED patients, since it was designed for that specific patient population. If patients fulfill all eight criteria, then the likelihood of PE is sufficiently low due it's high sensitivity and NPV.
- A normal D-Dimer assay is highly sensitive for ruling out PE if the probability is low or intermediate. When D-Dimer is used in conjunction with Wells' criteria, the sensitivity of the Wells' criteria greatly improves and that can help reduce the need for unnecessary testing. Of note, D-Dimer can be falsely positive in any acute or inflammatory process, elderly patients, renal disease, or sickle cell disease.
- If there is a concern for right heart dysfunction on physical exam (signs of volume overload), on labs (elevated cardiac markers), or on initial imaging (RV enlargement on CTPA) then the clinician should obtain a TTE to evaluate for RV strain.

References:

1. Alotaini, G.S., Wu, C., Senthilselva, A., McMurty, M.S. (2016). Secular Trends in Incidence and Mortality of Acute Venous Thromboembolism: The AB-VTE Population-Based Study. *The American Journal of Medicine*. Vol(129): 8. https://doi.org/10.1016/j.amjmed.2016.01.041
2. Bernal, A.G., Fanola, C., Bartos, J.A. (2020). Management of PE. *American College of Cardiology.* https://www.acc.org/Latest-in-Cardiology/Articles/2020/01/27/07/42/Management-of-PE
3. Jarman, A.F., Mumma, B.E., Singh, K.S., Nowadly, C.D., Maughan, B.C. (2021). Crucial considerations: sex differences in the epidemiology, diagnosis, treatment, and outcomes of acute pulmonary embolism in non-pregnant adult patients. *Journal of the American College of Emergency Physicians*. Vol(2): 1. https://doi.org/10.1002/emp2.12378
4. UpToDate (2023, June 5). Clinical presentation, evaluation, and diagnosis of the nonpregnant adult with suspected acute pulmonary embolism. Wolters Kluwer. Retrieved Oct 6 2023 from www.uptodate.com.
5. CDC (2023, June 28). Venous Thromboembolism: Data & Statistics. Retrieved Nov 9, 2023 from https://www.cdc.gov/ncbddd/dvt/data.html
6. Wells' Criteria for DVT (mdcalc.com)
7. PERC Rule for Pulmonary Embolism (mdcalc.com)