

IN THE NAME OF GOD

Non-Imaging Diagnosis of Pulmonary Embolism

Presented By: Dr.Fakhrmousavi.MD.Pulmonologist
Assistant Professor of Pulmonary Diseases
Guilan University of Medical Sciences

Pulmonary Embolism (PE) is a common phenomenon that can lead to significant clinical manifestations and sequelae. **Prompt diagnosis** is imperative to enable early treatment and improve outcome.

- The clinical presentation varies considerably ,dependent on the severity of the obstruction as well as the background clinical status of the patient. It can vary from being completely asymptomatic or lead to cardiogenic shock and sudden death.

- ▶ The most common clinical symptoms are shortness of breath and pleuritic chest pain with or without symptoms of deep vein thrombosis (DVT). However, the clinical spectrum is very diverse including absence of symptoms and symptoms that are not specific; therefore, the key to the diagnosis is a high index of suspicion, particularly if risk factors for thromboembolic disease are present.
- ▶ I.

Symptoms

- The most common symptoms include shortness of breath at rest or effort, pleuritic chest pain, cough, orthopnea, symptoms of DVT i.e., calf or thigh pain or swelling, wheezing and hemoptysis.

Table 1 Common symptoms and signs of pulmonary embolism

Symptoms	PIOPED I (%)	PIOPED II (%)	Signs	PIOPED I (%)	PIOPED II (%)
Dyspnea	73	73	Temperature >38.5 °C	7	1
Pleuritic pain	66	44	Abnormal Cardiac examination	–	21
Cough	37	34	Increased P2	23	15
Leg swelling	28	41	Right ventricular lift	4	4
Leg pain	26	44	Jugular venous distension	–	14
Hemoptysis	13	–	Abnormal Lung examination	–	29
Palpitations	10	–	Rales (crackles)	51	18
Wheezing	9	21	Wheezes	5	2
Angina-like pain	4	–	Rhonchi	–	2

Signs

- Common presenting signs on examination include tachypnea, tachycardia and signs of DVT including calf or thigh swelling, erythema, edema, tenderness or palpable cords. Other signs include rales, decreased breath sounds, accentuated pulmonic component of the second heart sound and jugular venous distension.

Signs			Decreased breath sounds	–	17
Tachypnea ($\geq 20/\text{min}$)	70	54	Pleural friction rub	3	0
Tachycardia ($>100/\text{min}$)	30	24	Calf or thigh DVT signs	11	47
Diaphoresis	11	2	Calf and thigh DVT signs		14
Cyanosis	1	0			

- ▶ The presence of these clinical symptoms and signs can help raise the clinical
- ▶ suspicion for PE, however, the sensitivity and specificity of making a diagnosis
- ▶ based on clinical symptoms and signs alone is fairly low.

- Therefore if there is a clinical suspicion, risk assessment for the probability of diagnosis should be performed and further testing conducted based on this, primarily a blood test for the biomarker D-dimer.

Thromboembolic Risk

- ▶ Predisposing factors include major surgery, multiple trauma, hip fracture, or lower extremity paralysis because of spinal cord injury. Additional risk factors include previous VTE, increasing age, cardiac or respiratory failure, prolonged immobility, presence of central venous lines, estrogens, and a wide variety of inherited and acquired hematological conditions.

- ▶ However, it is important to keep in mind that a non-significant minority of patients with PE (*40%), do not have any apparent predisposing factors.

Pretest probability Scores for the Diagnosis of PE

- ▶ A more accurate and standardized way to calculate the risk of PE is based on several validated scores estimating the probability for PE. The scores include the Wells, modified Wells, simplified Wells, the revised Geneva or simplified Geneva Score.

Table 2 Clinical scores to estimate the probability of pulmonary embolism

Variable	Wells	Simplified Wells	Variable	Revised Geneva	Simplified Geneva
Clinical signs and symptoms of DVT	3	1	Pain on lower limb deep venous palpation and unilateral edema	4	1
			Unilateral lower-limb pain	3	1
Alternative diagnosis less likely	3	1			
Heart rate >100 beats per minute	1.5	1	Heart rate ≥ 95 beats per minute	5	2
			Heart rate 75–94 beats per minute	3	1
Previous DVT/PE	1.5	1	Previous DVT/PE	3	1
Immobilization (≥ 3 days) or surgery in the previous four weeks	1.5	1	Surgery under general anesthesia or fracture of the lower limbs within one month	2	1
Malignancy	1	1	Active malignancy (last year)	2	1
Hemoptysis	1	1	Hemoptysis	2	1
			Age >65 years	1	1
<i>Clinical probability</i>			<i>Clinical probability</i>		
High	≥ 7	–	High	≥ 11	≥ 5
Intermediate	2–6	–	Intermediate	4–10	2–4
Low	<2	–	Low	0–3	0–1
Two-level score (modified wells)			Two-level score		
PE likely	≥ 5	≥ 2	PE likely	≥ 6	≥ 3
PE unlikely	0–4	0–1	PE unlikely	0–5	0–2

- ▶ The sensitivity of these scores ranged from 88 to 96% with lower specificity from 48 to 53%. Pretest probability of PE using one of these scores is recommended to classify the clinical probability risk as low, intermediate or high . Based on this classification, further evaluation is indicated, including D-dimer or imaging studies.

Biomarkers

- ▶ D-dimer is a fibrin degradation product that is produced with acute thrombosis and
- ▶ is a very sensitive biomarker of acute PE but a low specificity. A negative result
- ▶ rules out PE in patients with an intermediate or low clinical probability of PE.
- ▶ A positive result suggests PE but is not specific enough to make the diagnosis and
- ▶ further evaluation is needed.

- ▶ D-dimer testing is best done using rapid highly sensitive newer-generation
- ▶ assays using latex-agglutination-based or rapid enzyme-linked immunosorbent
- ▶ assays (ELISA) that yield a high sensitivity (96%) and provide a high negative
- ▶ predictive value (98%) . Cutoff levels for a positive test are D-dimer 500 μg / L.

- D-dimer is elevated in several situations including increasing age, cancer, severe infection, hospitalization or active inflammatory disease and in pregnancy and this needs to be taken into account. Age-adjusted cutoffs are available and may improve the accuracy of the assay in older subjects. Using the cutoff of $\text{age} * 10 \text{ ng/L}$ for patients >50 years, provides a high negative predictive values for ruling out PE in low to intermediate risk probability subjects

YEARS clinical decision

- ▶ Another approach uses the combination of clinical probability and D-dimer at
- ▶ different cutoff levels. This diagnostic algorithm uses the YEARS clinical decision
- ▶ rule that incorporates differential D-dimer cutoff values at presentation in conjunction
- ▶ with 3 clinical items including **clinical signs of DVT**, **hemoptysis**, and
- ▶ whether **pulmonary embolism is the most likely diagnosis**. PE can be excluded in
- ▶ patients **without YEARS items and D-dimer <1000 ng/mL**, or in patients with **one**
- ▶ **or more YEARS items and D-dimer <500 ng/mL**.

D-dimer Usage

- ▶ Low and intermediate probability for PE D-dimer should be used primarily to
- ▶ rule-out PE in patients with a low and intermediate probability for PE.

PERC rule

- ▶ it is also possible to use the pulmonary embolism rule out criteria (PERC) rule that helps rule out PE and therefore measuring D-dimer is not required . The PERC rule was constructed to identify patients with a very low clinical probability of PE that have such a low risk that it is unnecessary to do further testing . The PERC score includes age <50 years, heart rate <100 bpm , oxyhemoglobin saturation 95%, without hemoptysis, without estrogen use, without prior DVT or PE, without unilateral leg swelling and without surgery or trauma requiring hospitalization within the prior four weeks. Patients with all eight criteria do not need further testing and PE can be ruled out.

- ▶ High probability for PE Patients with a high probability risk do not need a D-dimer test, this patients, further evaluation with imaging is mandatory in any case.

Troponin

- ▶ Troponin I and T levels are the most sensitive and specific biomarkers of
- ▶ myocardial injury. In the context of PE, they signify RV strain and dysfunction,
- ▶ suggesting a larger and possibly a hemodynamically significant PE. While
- ▶ Troponin levels do not have diagnostic utility in PE, they provide important
- ▶ prognostic information.

- ▶ A metanalysis demonstrated a five-fold increase in mortality in patients with a
- ▶ positive troponin test and this was also seen in a subgroup of hemodynamically
- ▶ stable patients.

Natriuretic Peptides

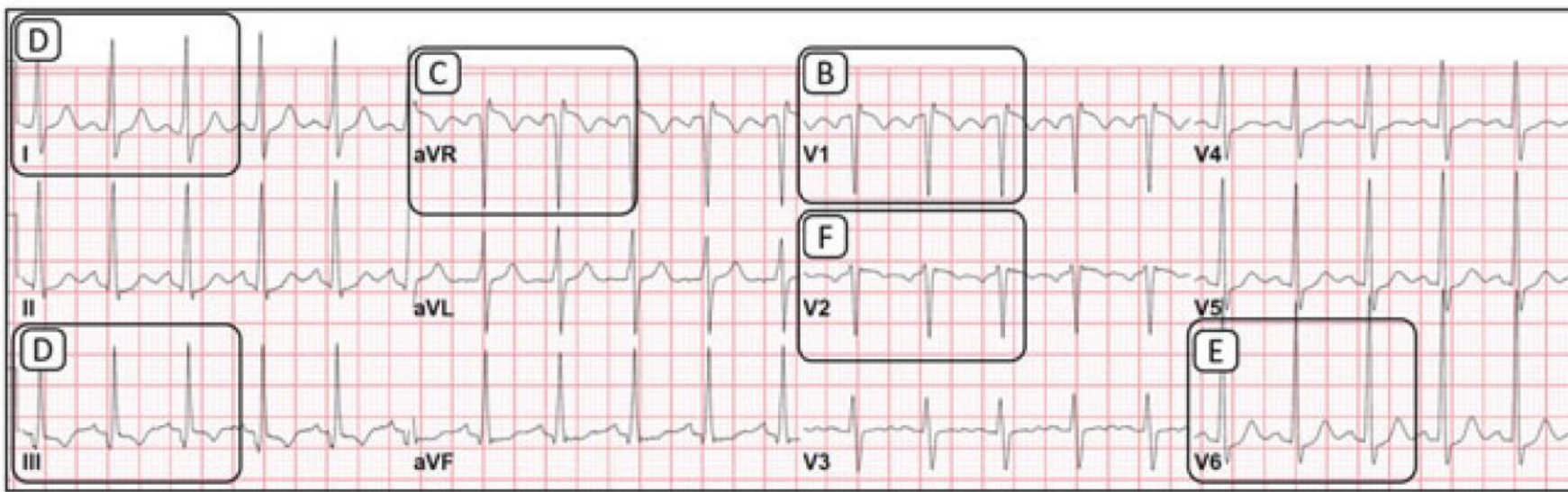
- ▶ Natriuretic peptides (NP) including BNP or N-terminal (NT)-proBNP are secreted
- ▶ from cardiac chambers, particularly the ventricles, and rise in situations where there
- ▶ are elevated cardiac filling pressures. These peptides are valuable in evaluating a
- ▶ hemodynamically significant pressure on the right ventricle due to a large PE. NP
- ▶ were shown to be associated with increased RV volume and were predictive of
- ▶ RV dysfunction in PE . Like troponin, they have low diagnostic yield. They are
- ▶ not recommended as part of the standard initial evaluation of acute PE.

- ▶ Current guidelines do not recommend NP testing as part of the standard evaluation of patients with PE.

Electrocardiogram

- ▶ Its main purpose is to suggest alternative diagnoses that need to be recognized and treated. Classic electrocardiographic abnormalities of pulmonary embolism are helpful in suggesting PE; however, the absence of such abnormalities has a low predictive value.
- ▶ The most common abnormalities found on the ECG in acute PE are tachycardia (38%) , T-wave inversion in lead V1 (38%), , and ST elevation in lead aVR (36%).

- ▶ The classical **S1Q3T3** pattern consisting of a prominent S wave in lead I, Q wave
- ▶ and inverted T wave in lead III is specific and suggestive of PE, however
- ▶ it is insensitive, occurring in only 15–25% of patients with PE. More importantly,
- ▶ this sign is predictive of RV strain and increases the risk of adverse events.
- ▶ Additional findings suggesting PE are new-onset complete or **incomplete RBBB**
- ▶ **, inverted T waves in V1–V4 , P-pulmonale, rightward shift of the QRS axis and atrial arrhythmias, particularly atrial fibrillation.**



A ECG of acute PE with Tachycardia



Inverted T wave



ST elevation



S wave

Q wave Inverted T wave



R' wave

S wave



Inverted T waves precordial V1-V4

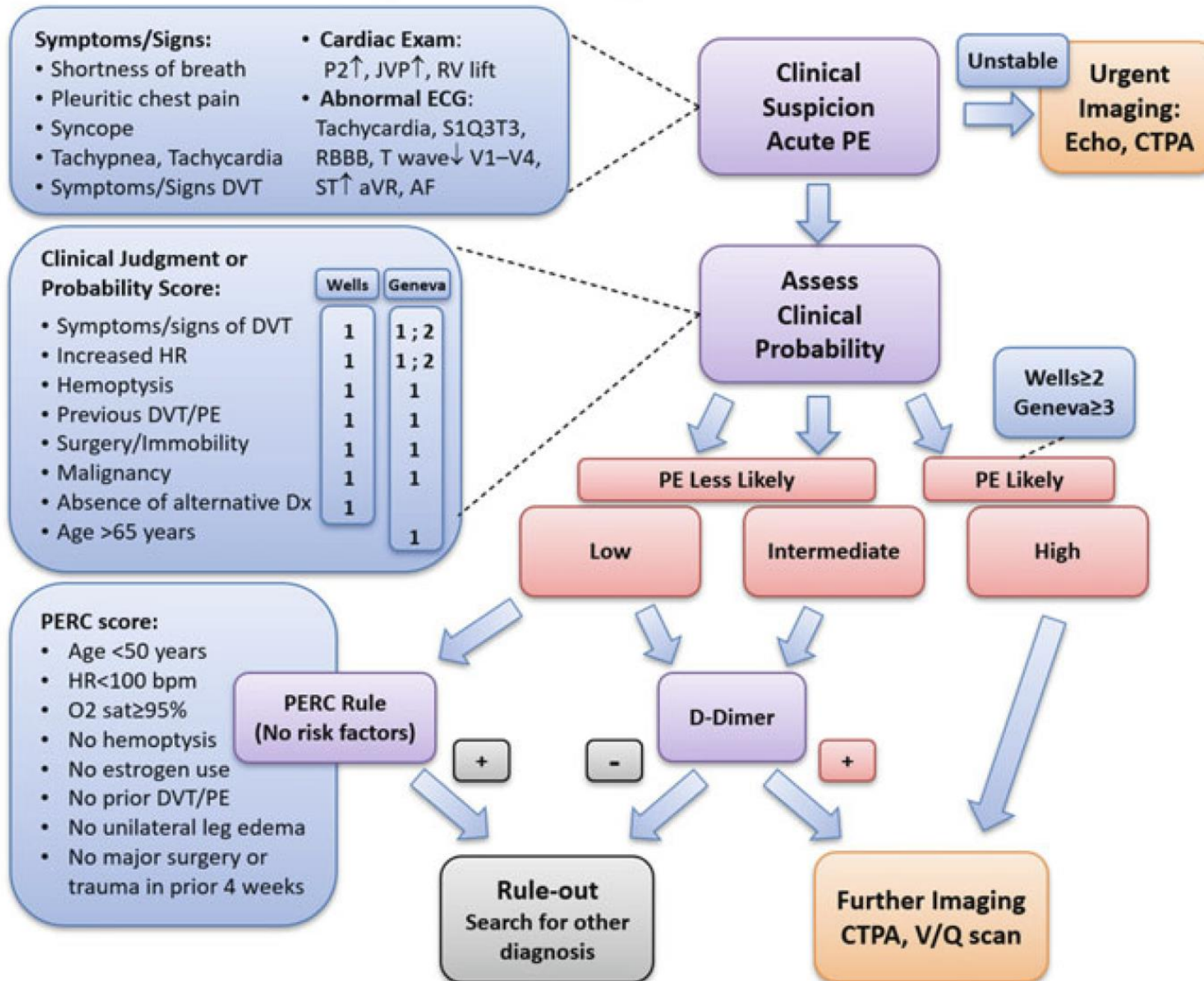
Chest X-ray

- ▶ The chest X-ray is not specific and may be normal in a quarter of patients with PE.
- ▶ The most common abnormal findings on the X-ray are cardiac enlargement (27%),
- ▶ pleural effusion (23%), elevated hemidiaphragm (20%), pulmonary artery
- ▶ enlargement (19%), atelectasis (18%) and parenchymal pulmonary infiltrates (17%)
- ▶ . However, cardiac enlargement or pulmonary artery enlarged were neither
- ▶ sensitive or specific for RV dysfunction. The chest X-ray is more helpful in
- ▶ excluding other causes of shortness of breath or chest pain.

Arterial Blood Gases

- ▶ Arterial blood gas, while not specific for PE, is usually abnormal and can provide
- ▶ prognostic information regarding the severity of the PE. Hypoxemia without
- ▶ obvious lung findings on physical examination and chest X-ray, should raise the
- ▶ index of suspicion for PE. The most common findings seen with PE are hypoxemia,
- ▶ widened alveolar-arterial gradient for oxygen and low CO₂. However, the blood gas
- ▶ may be also be normal. Hypoxemia usually suggests a more extensive PE and
- ▶ oxygen saturation below 95% increases the risk of complications as well as death

Initial Diagnostic Algorithm – Acute PE



Thanks for your attention

