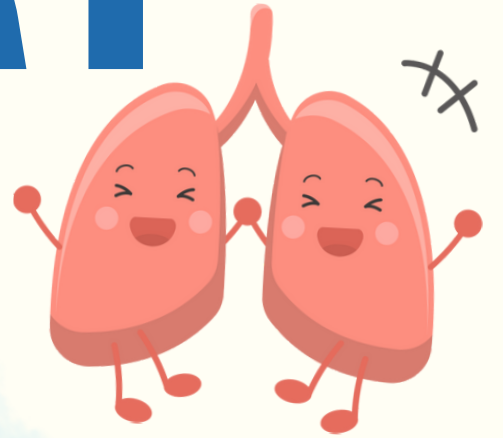
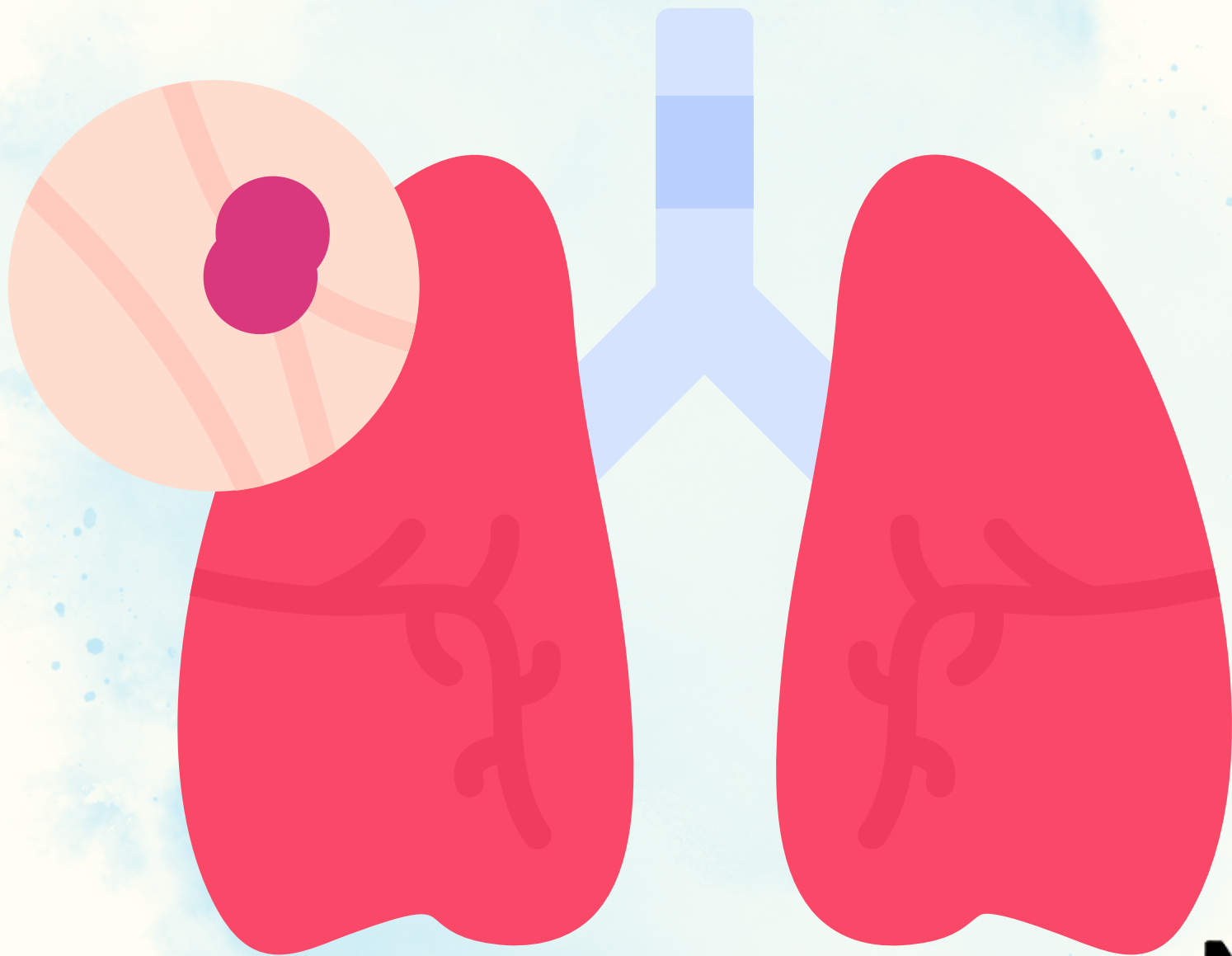


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PULMONARY EMBOLISM



[PART 1: DEFINITION, RISK FACTORS, CAUSES, CLINICAL FEATURES]



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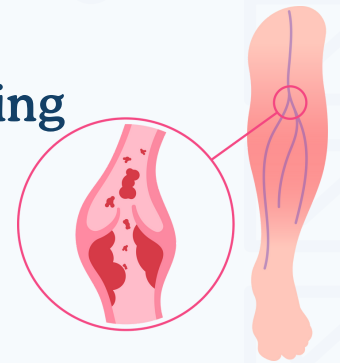
Definition



Deep Vein Thrombosis (DVT):

Venous thrombosis originates in the deep veins of the leg

- Calf/Distal DVT-> Thrombus confined to calf veins
- Proximal DVT-> Thrombus extended proximally, reaching popliteal vein or above



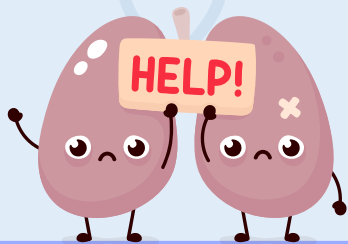
Pulmonary Embolism (PE):

The thrombus embolises through the circulation into pulmonary arteries

A minority (about 10%) of episodes of venous thrombosis arise in:

1. Upper limb
2. Cerebral venous sinuses
3. Splanchnic veins

Types of PE



Types of PE

Features

Massive

- Obstructive shock/SBP < 90 mmHg



Submassive

- Without systemic hypotension (SBP $\geq$ 90 mm Hg)
- With RV dysfunction/myocardial necrosis

Non-massive/Low risk

- Without any severe features above



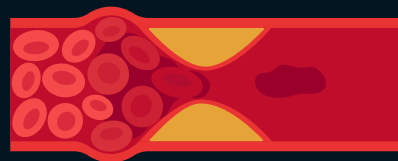
Risk Factors



REMEMBER: THROMBOSIS

1. Trauma

Endothelial Injury



THROMBOSIS



Abnormal Blood Flow

1. Orthopedic surgery
2. Immobilization

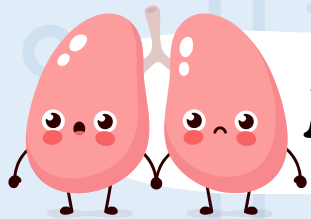


Hypercoagulability

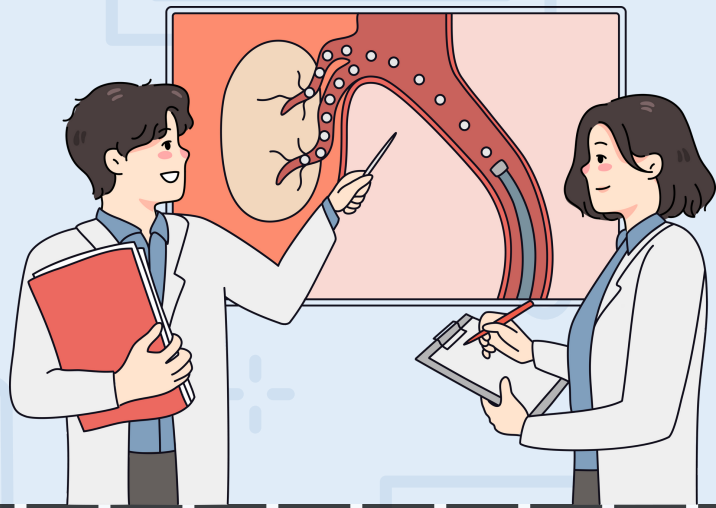
1. Hormonal
2. Malignancy
3. Blood disorders
4. Old age/Obesity
5. Syndromes
6. Serious illness



Causes



Most Common Causes: DVT



Causes of non thrombotic embolism:

- Fat embolism
- Air embolism
- Amniotic fluid embolism

Fat Embolism Syndrome:
Usually after **long bone fractures**

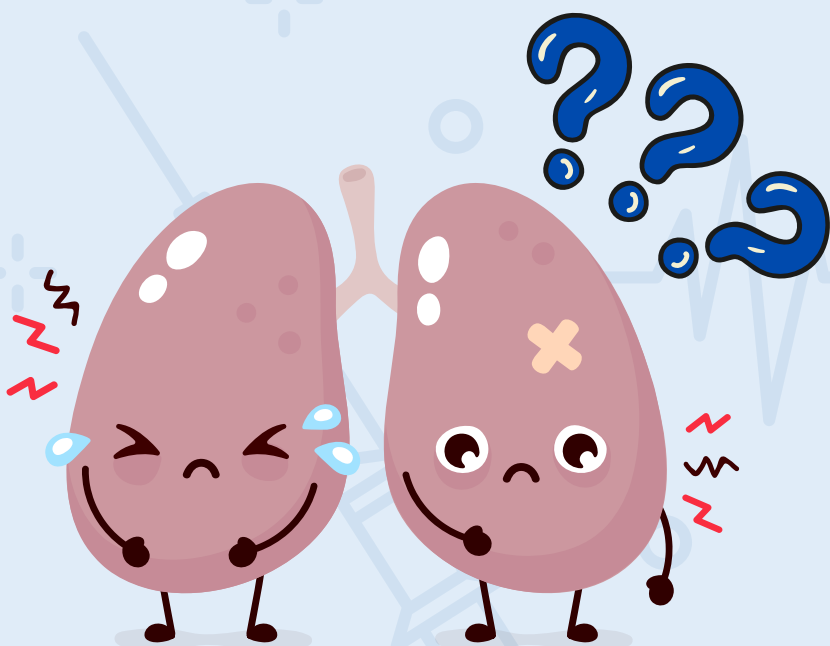


Classic Triad of Fat Embolism:

- Respiratory distress
- Neurological abnormalities
- Petechial rash (typically on the upper body)



Fat embolism syndrome is rare but deadly. Recognize the triad!!



Clinical Features



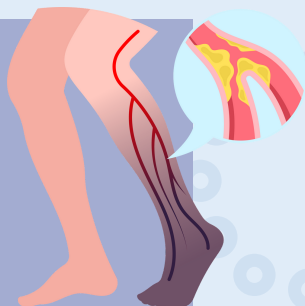
Signs

Tachypnea



Rales

Leg swelling (due to concomitant deep venous thrombosis)



Sinus tachycardia



Hypoxia/low oxygen saturation



Fourth heart sound

Accentuated pulmonic component of second heart sound

Other tachyarrhythmias (e.g. Afib)



Circulatory collapse

More likely

Symptoms



Dyspnea (at rest or with exertion; often sudden in onset)

Pleuritic chest pain



Cough



Leg pain (due to concomitant DVT)

Hemoptysis



Syncope/presyncope



Orthopnea

Wheeze

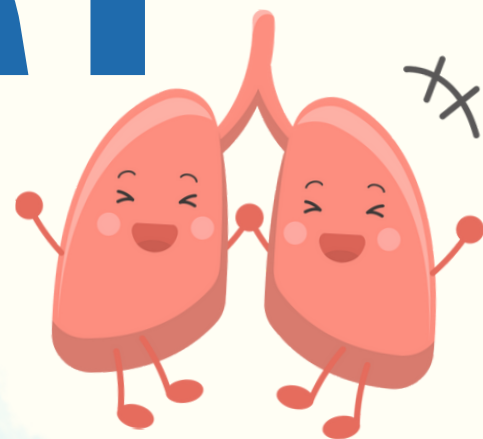
Hoarseness (due to dilated pulmonary artery)

Less likely

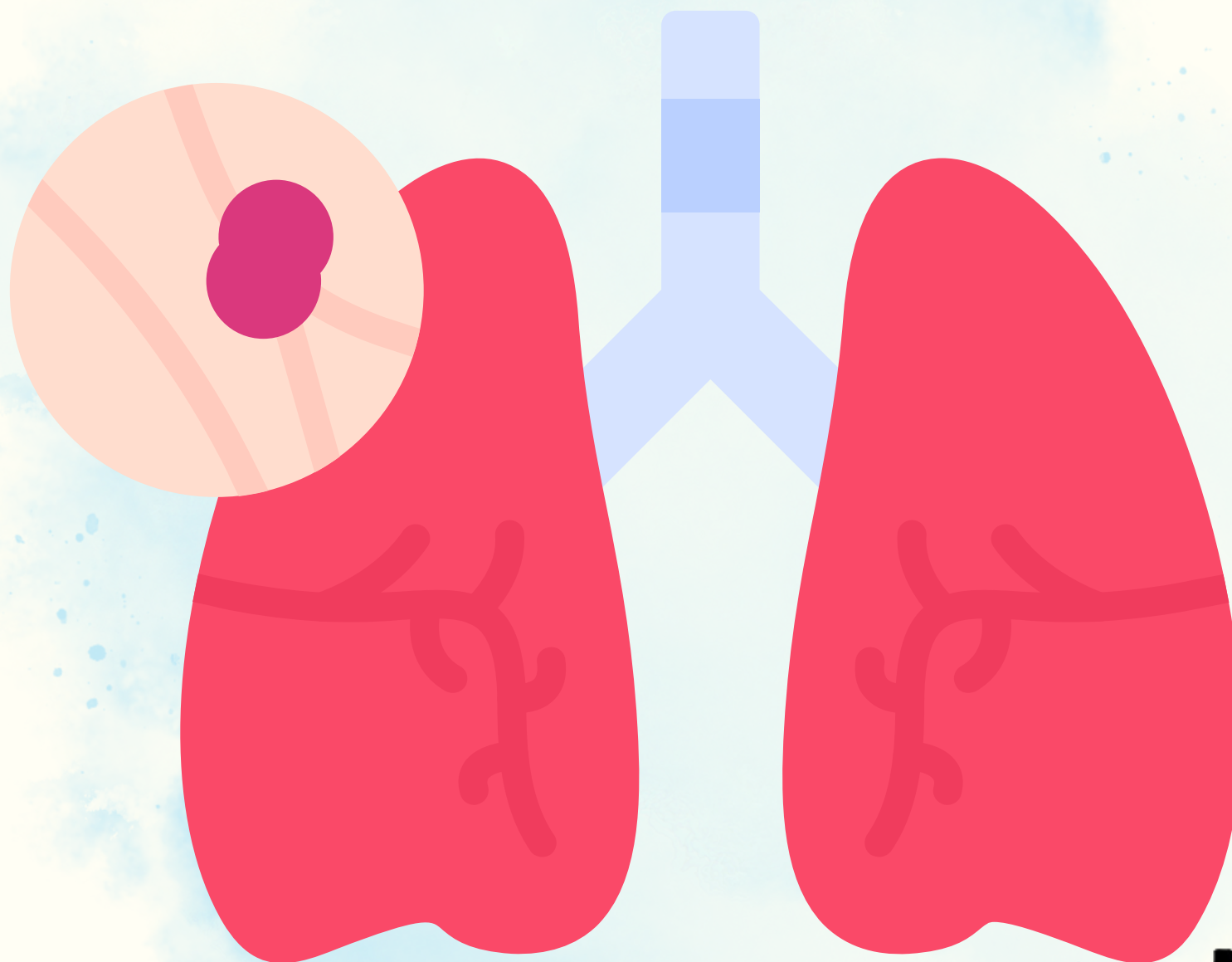


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PULMONARY EMBOLISM



[PART 2: WELL'S SCORE, PERC RULE, INVESTIGATIONS]



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Well's Criteria for PE



Criteria	No	Yes
Clinical signs and symptoms of DVT	0	+3
PE is #1 diagnosis OR equally likely	0	+3
Heart rate > 100	0	+1.5
Immobilisation at least 3 days OR surgery in the previous 4 weeks	0	+1.5
Previous, objectively diagnosed PE or DVT	0	+1.5
Haemoptysis	0	+1
Malignancy with treatment within 6 months or palliative	0	+1

How to interpret?

Two tier model:

- ≤ 4 : unlikely
- ≥ 4.5 : likely



PE Rule-out Criteria (PERC)



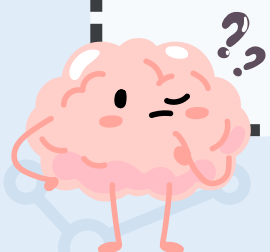
Decision rules for patients who have a low probability of PE:

Criteria	No	Yes
Age ≥ 50	0	+1
HR ≥ 100	0	+1
O ₂ sat on room air $< 95\%$	0	+1
Unilateral leg swelling	0	+1
Hemoptysis	0	+1
Surgery or trauma ≤ 4 weeks ago requiring treatment with general anesthesia	0	+1
Prior PE or DVT	0	+1
Oral contraceptives, hormone replacement or estrogenic hormones	0	+1

PERC score

How to interpret?

- 0 : PE ruled out (PERC Rule negative)
- ≥ 1 : PE not ruled out (PERC rule positive)



Diagnostic Investigations



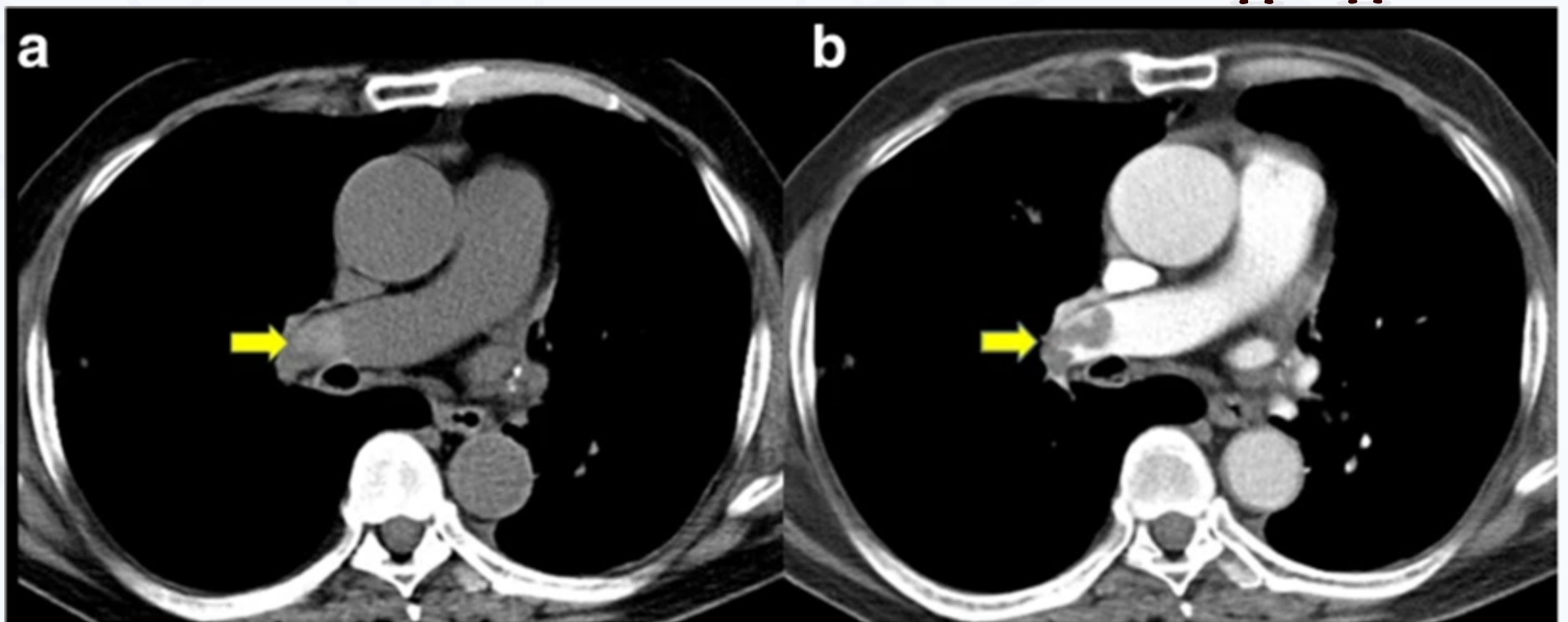
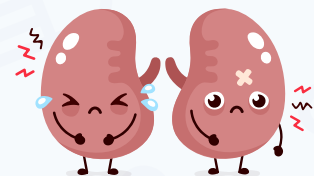
1. D-dimer ↑ (Initial approach)

- D-dimers are fibrin degradation products
- High negative predictive value



2. CTPA (GOLD standard → Diagnostic imaging)

- CT scan with intravenous contrast to highlight the pulmonary vessels
- Contraindications: contrast allergy, kidney function impairment ($\text{eGFR} < 30 \text{ ml/min/1.73m}^2$)

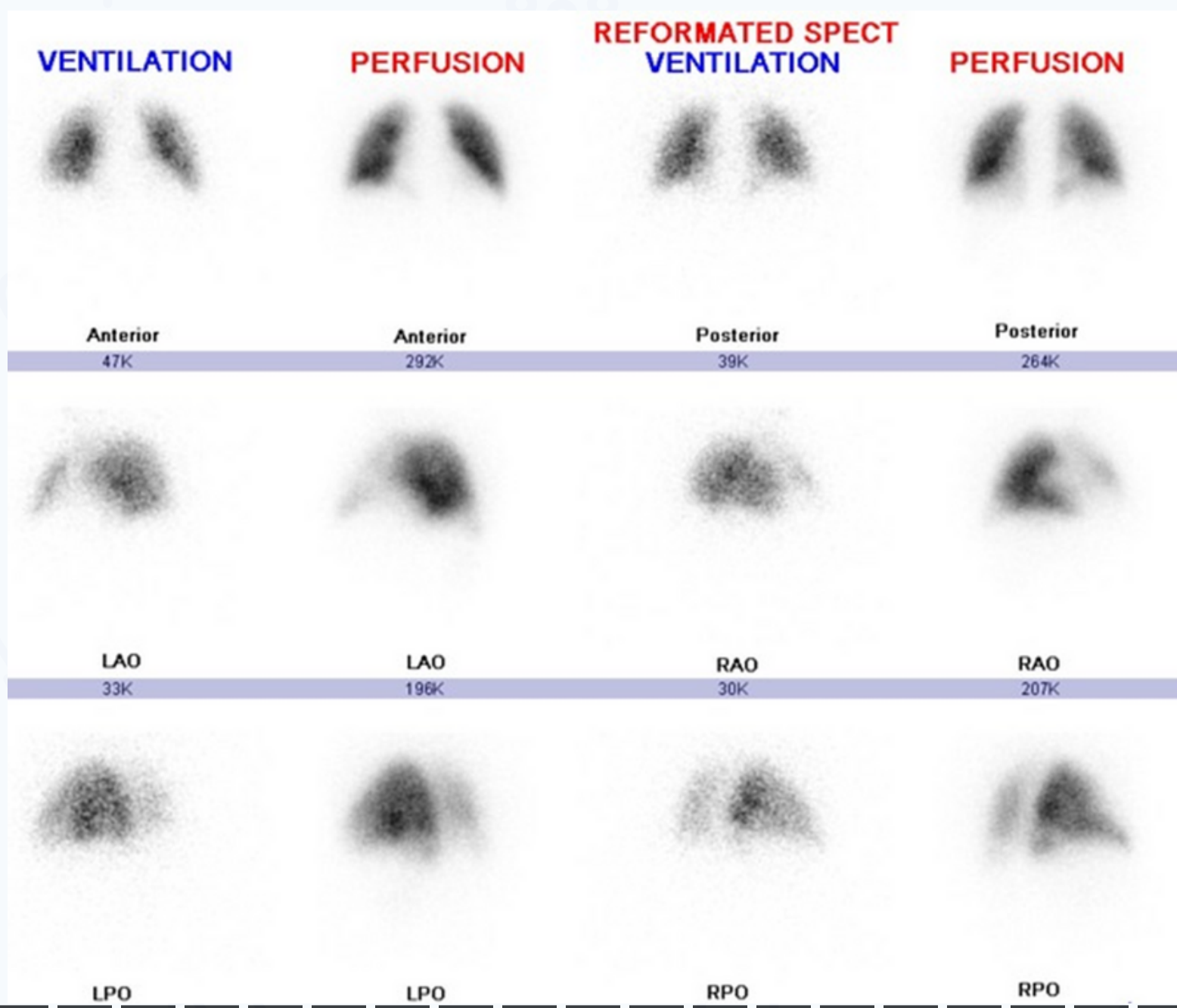


Diagnostic Investigations



3. V/Q scan

- 2 scans done:
 - Perfusion scan: injected technetium-99m-labeled macroaggregated albumin to assess blood flow
 - Ventilation scan: inhaled radioactive gas or aerosol to assess airflow
 - Result: V/Q mismatch → **normal ventilation with impaired perfusion**
- Alternative imaging done when **CTPA cannot be performed / is indeterminate**
- **Imaging of choice in pregnancy** (lesser radiation dose)



Other Investigations



1. ECG

- Non-specific ST segment and T wave changes (50%)
- Sinus tachycardia (44%)
- **SI QIII TIII pattern** ($\approx 20\%$)
 - Deep S wave in lead I, Q wave in III, inverted T wave in III
 - **"Classic" finding**
 - Neither sensitive nor specific
- RBBB (18%)
- Right ventricular strain pattern (34%)
- Right axis deviation (16%)
- P pulmonale (9%)



Q Massive bilateral pulmonary embolus ×

RBBB

T-wave inversions

S1 Q3 T3

T-wave inversions

Extreme right axis deviation

T-wave inversions

S1 Q3 T3

Extreme right axis deviation

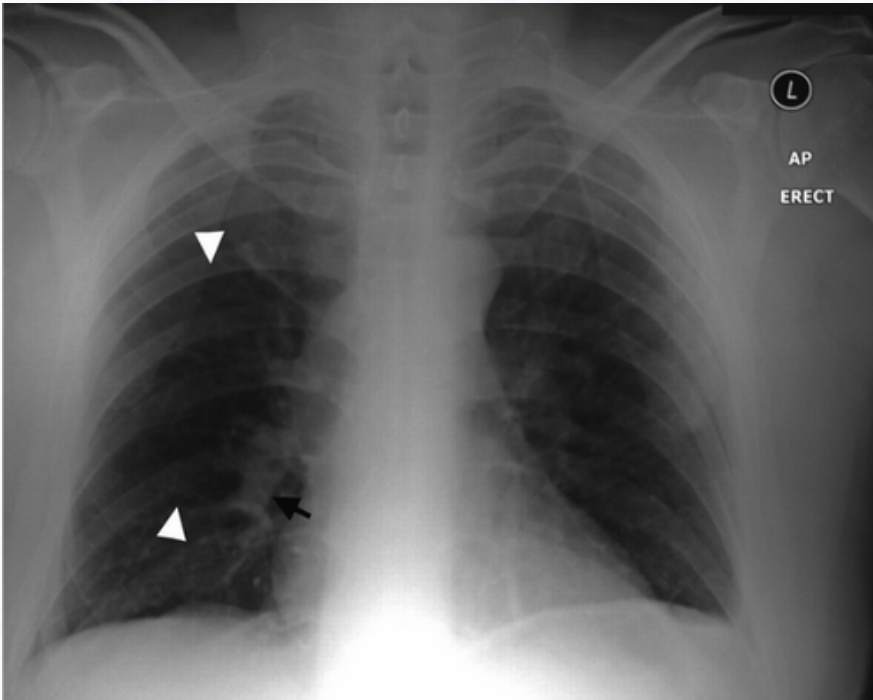
- RBBB (red arrow)
- Extreme right axis deviation (blue + -)
- S1 Q3 T3 (green arrow)
- T-wave inversions in V1-4 and lead III (purple arrow)



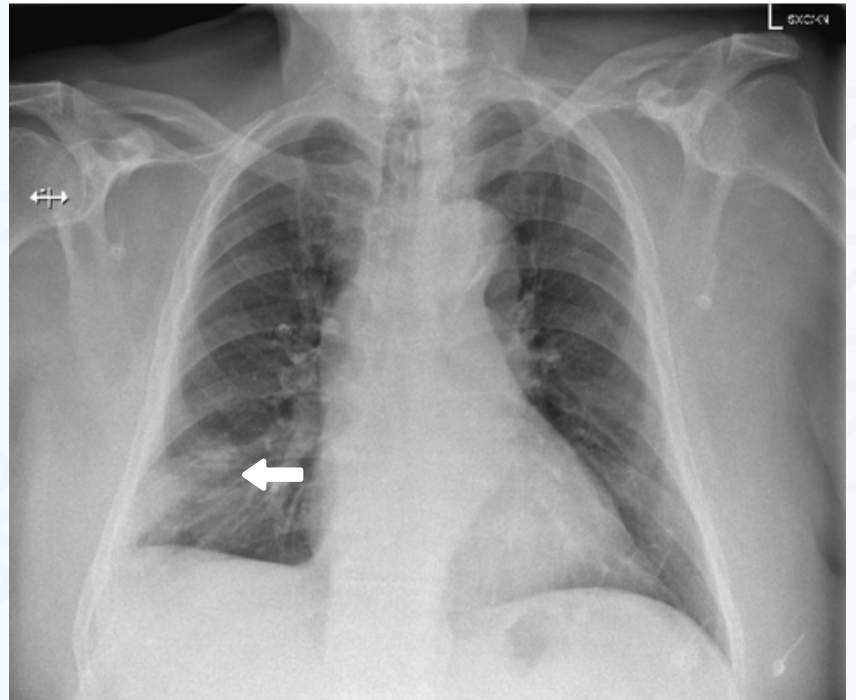
Other Investigations



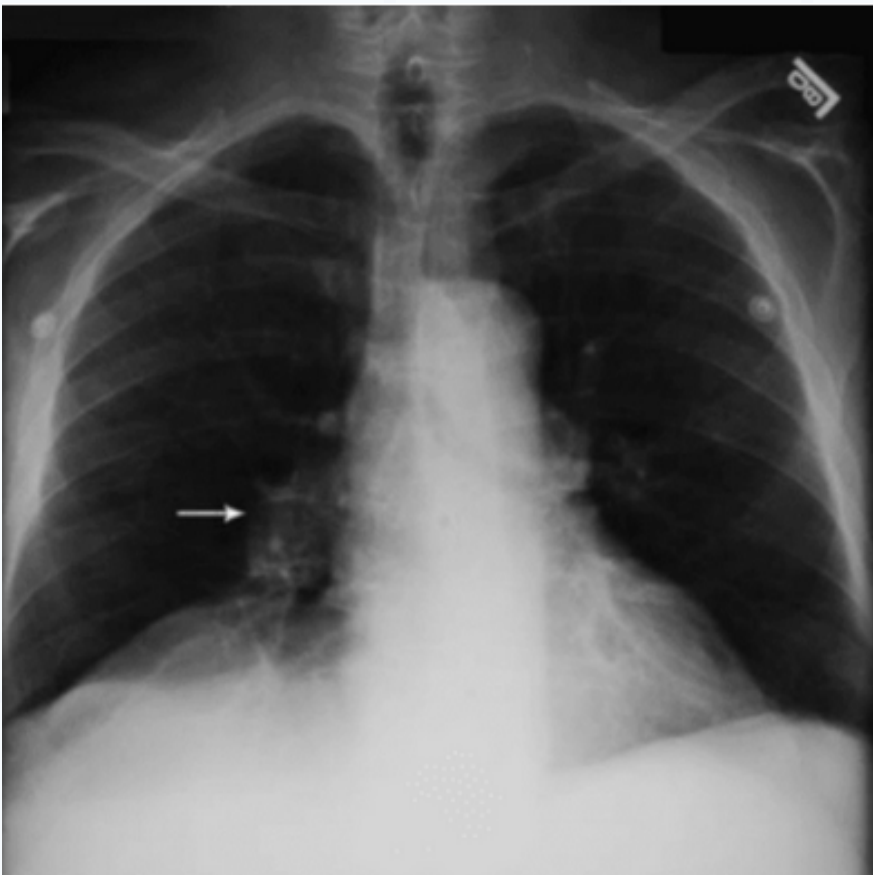
2. Chest X-Ray



Westermark sign (focal oligemia)



Hampton hump (wedge-shaped peripheral consolidation from infarction)



Fleischner sign (enlarged pulmonary artery)

Non-specific abnormalities

- Atelectasis
- Parenchymal abnormalities
- Cardiomegaly
- Hemidiaphragm elevated
- Pleural effusion

Arterial blood gas analysis

- Hypoxia
- Hypocapnia



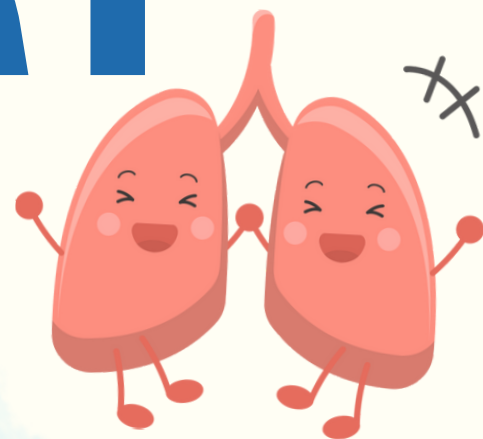
Biomarkers of cardiac injury

- Brain natriuretic peptide (BNP) ↑
- Amino-terminal pro-BNP ↑

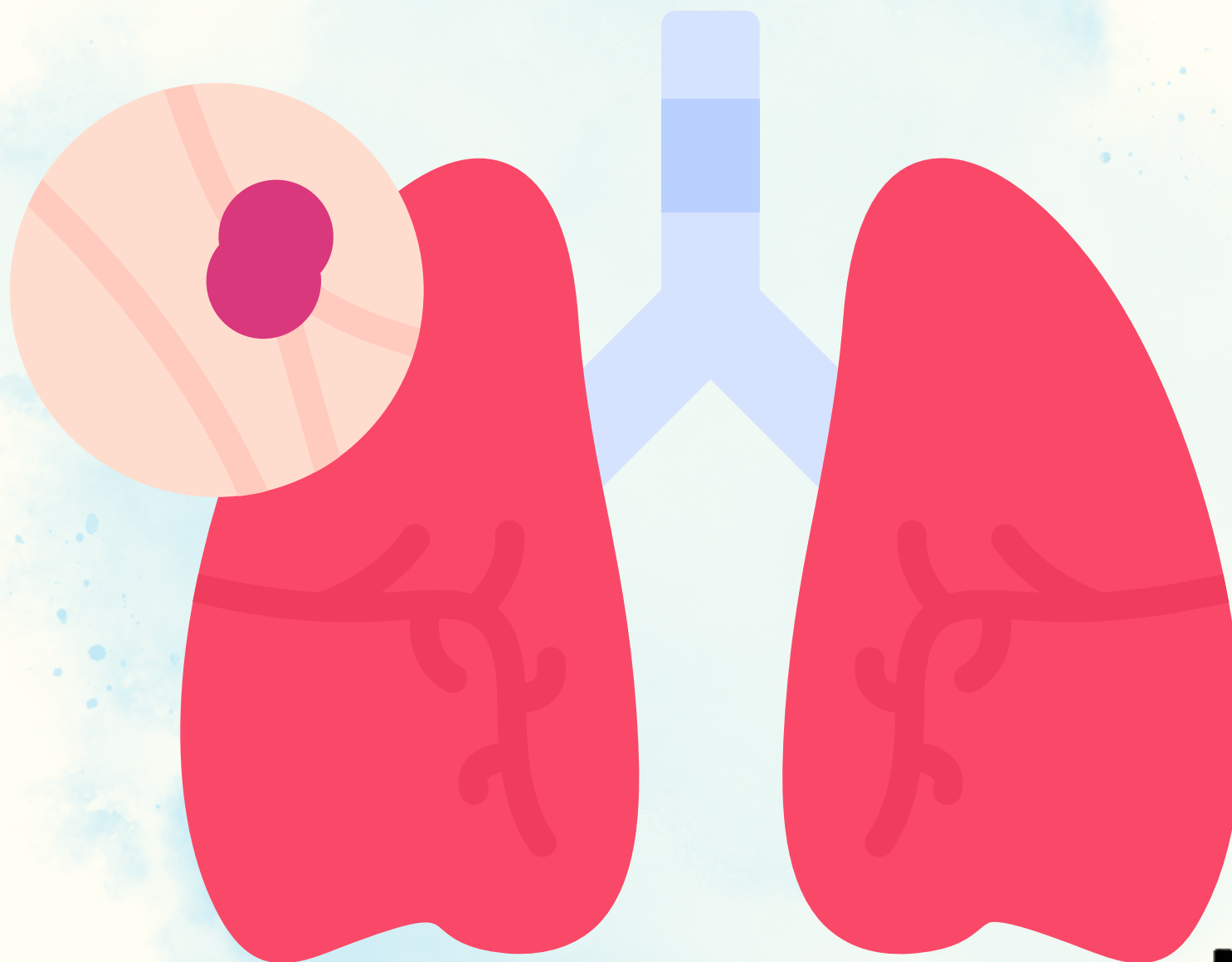


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PULMONARY EMBOLISM

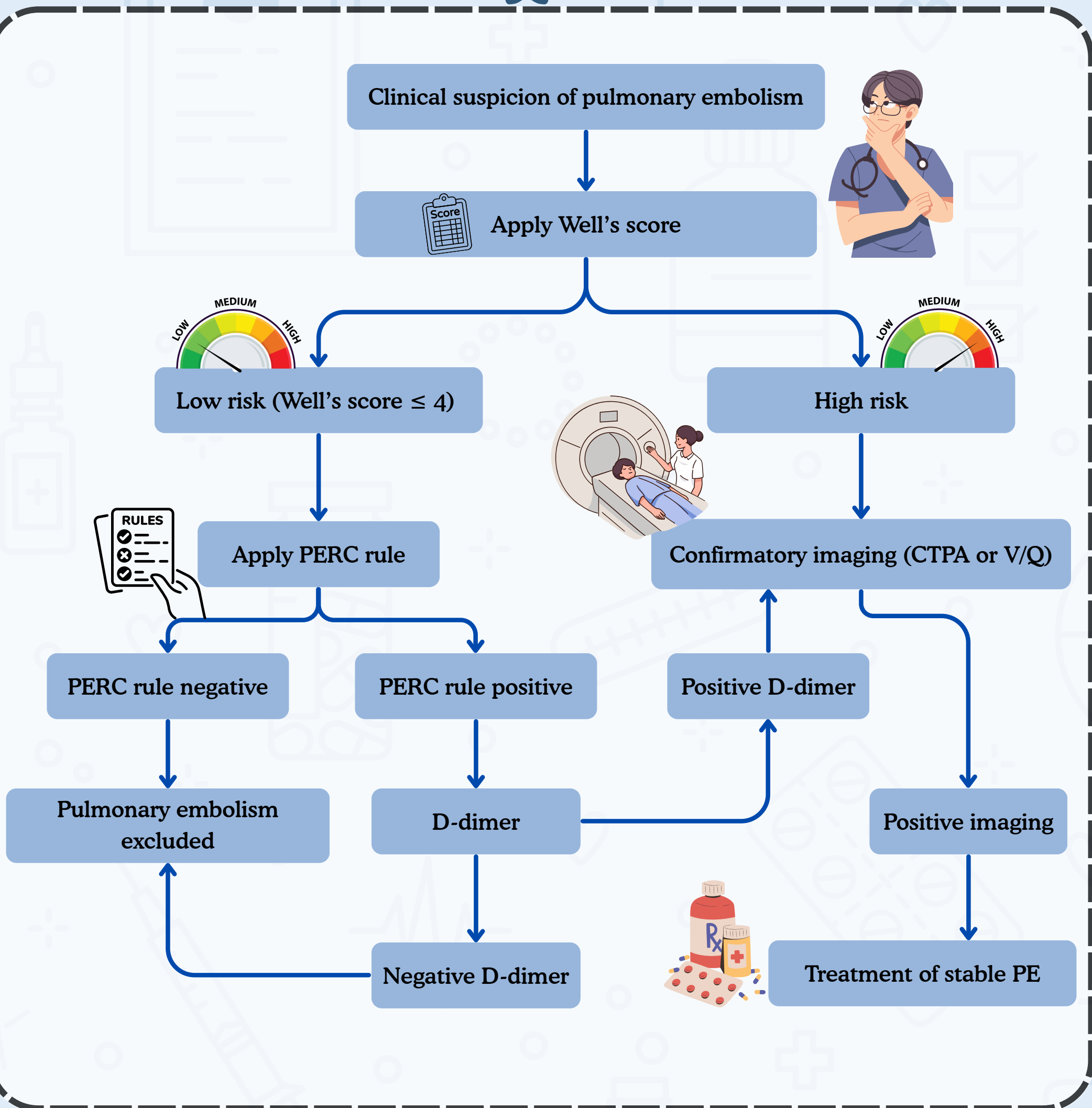


[PART 3: STEPWISE APPROACH & MANAGEMENT]



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Stepwise Approach in Stable PE



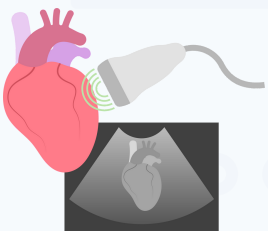
Stepwise Approach in Unstable PE



Suspected PE in a patient with haemodynamic instability



Stabilise the patient



Bedside echocardiogram

RV dysfunction

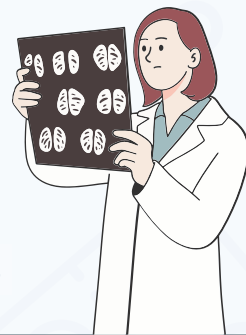
In haemodynamically unstable patients:

- Signs: cardiac arrest, shock, persistent hypotension
- High risk of death from PE due to right ventricular (RV) dysfunction

No

Yes

CTPA immediately available and feasible?



No

Yes

Confirmatory imaging, CTPA

Positive

Negative

Search for other causes of instability

Treatment of unstable PE

Search for other causes of instability



For stable PE: Anticoagulation

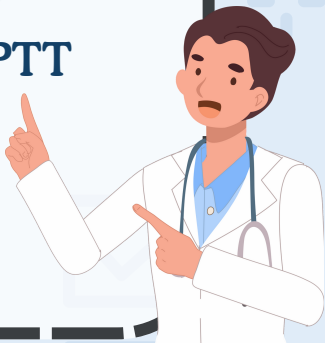


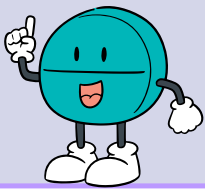
If Anticoagulant is contraindicated-> IVC Filter



For stable PE: Anticoagulation

- Obtain baseline full blood count, renal and hepatic function, PT and APTT
- Start anticoagulation before results are available
- Review and if necessary act on results within 24 hours.
- Duration: at least 3 months (*read more on our website notes!!!*)



DOACS (Direct Oral Anticoagulants)	Vitamin K antagonist	Heparin 
• Factor Xa inhibitors: rivaroxaban, apixaban • Thrombin inhibitors: dabigatran	Warfarin	Parenteral anticoagulants • UFH • LMWH (enoxaparin, dalteparin, fondaparinux)
Does not require monitoring	Monitor PR, INR 	• UFH: Monitor aPTT • LMWH: Monitoring not usually required
NOT require initial parenteral anticoagulant (unlike dabigatran and warfarin)  Factor Xa Inhibitors → Preferred anticoagulants • Can be used in active cancer Contraindication: • Severe renal impairment	Can be used in: • Severe kidney impairment • Other indications of warfarin: antiphospholipid syndrome Contraindication: • Pregnancy 	LMWH • Severe kidney impairment • Pregnancy • Breast feeding • Active cancer UFH • Severe kidney impairment • High risk of bleeding that requires rapid reversal of anticoagulation Also used as bridging therapy: • For at least 5 days ◦ Concurrently with warfarin ◦ Before starting dabigatran



For stable PE: Anticoagulation



Circumstances

- Unprovoked
- Transient (non-surgical) risk factor
- Active cancer



- Caused by major surgery or trauma that is no longer present

Duration of therapy



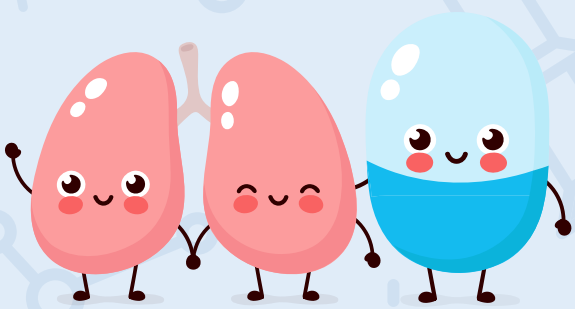
3 to 6 months, followed by consideration of extended therapy

3 months



Extended therapy is given as

- Low-intensity anticoagulant therapy
 - Persistent provoking factor
 - Apixaban OR Rivaroxaban
- Full-dose therapeutic anticoagulation
 - 2 or more unprovoked VTEs
 - Antiphospholipid syndrome
- Low-dose aspirin
 - Another indication (eg acute coronary syndrome, insertion of a drug-eluting stent)



For unstable PE: Reperfusion therapy



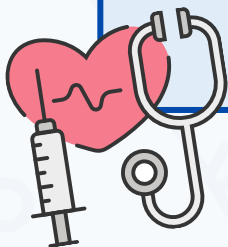
Thrombolysis (low bleeding risk):

Systemic/ catheter-directed thrombolytic therapy :

- Alteplase OR Tenecteplase
- Contraindications of Thrombolytic therapy:



Absolute	• History of haemorrhagic stroke or stroke of unknown origin • Ischaemic stroke in previous 6 months • Central nervous system neoplasm • Major trauma, surgery, or head injury in previous 3 weeks • Bleeding diathesis • Active bleeding
Relative	• Transient ischaemic attack in previous 6 months • Oral anticoagulation • Pregnancy or first postpartum week • Non-compressible puncture sites • Traumatic resuscitation • Refractory hypertension • Advanced liver disease • Infective endocarditis • Active peptic ulcer

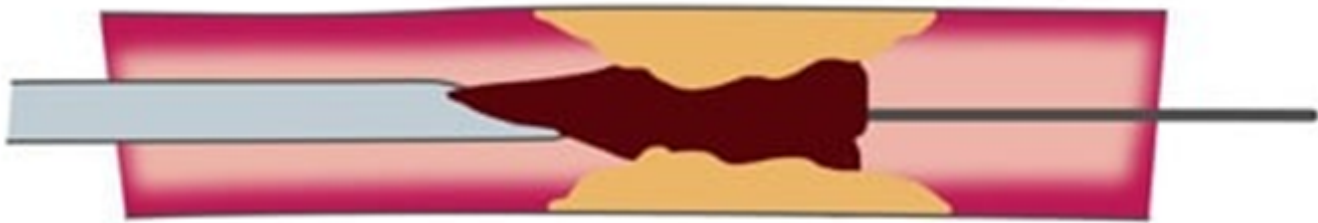


For unstable PE: Reperfusion therapy



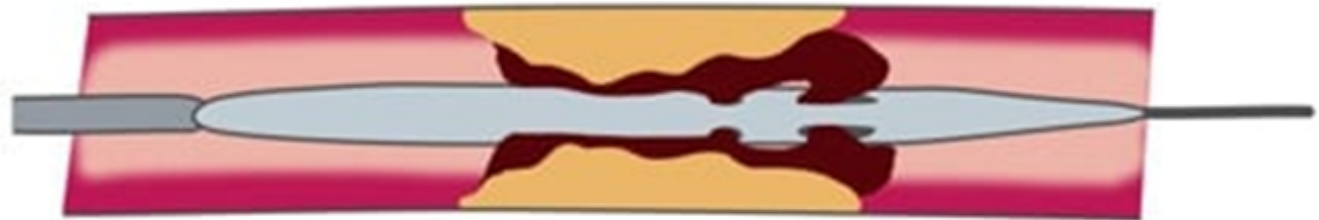
Embolectomy (high bleeding risk/ failure of thrombolysis):

- Aspiration embolectomy



Blood clot is removed using suction

- Surgical embolectomy



Blood clot is broken up into small pieces and removed

After reperfusion therapy:

- Anticoagulation (low bleeding risk)
- IVC filter (high bleeding risk)



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