PULMONARY EMBOLISM

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BACKGROUND

- PE is a form of VTE that is common and potentially fatal
- Clinical presentation is varied making diagnosis challenging

PE – defined as obstruction to the pulmonary artery or one of its branches by material (THROMBUS, tumour, air or fat) that originated elsewhere in the body

NOMENCLATURE

- Can be classified in many different ways

1. Haemodynamic stability
   - ”Massive” or high risk – persisting instability
   - “Submassive” or Intermediate risk – stable but right ventricular strain
   - Low risk – stable and no RV strain
2. Anatomical location eg; Saddle, lobar, segmental, subsegmental
3. Chronicity – acute, subacute, chronic

EPIDEMIOLOGY

- Males > females
- Increases with age, especially in women
- USA 100,000 deaths per year
- Majority of VTE deaths due to hospital-acquired PE

RISK FACTORS

- Pathogenesis of PE is the same as for VTE
- “Virchows triad”
- Can be broken up into
  - Inherited – eg: factor V Leiden, antiphospholipid syndrome
  - Acquired
    - Provoking – surgery, trauma, immobilization, hormone therapy, active cancer
    - Non-provoking – obesity, smoking
- Most come from DVT’s of the lower limb PROXIMAL veins – iliac, femoral, popliteal
- Below knee calf veins rarely embolise to the lung

CONSEQUENCES OF PE

1. Infarction
2. Abnormal gas exchange
3. Cardiovascular compromise

PRESENTATION

- Wide range – almost no Sx to sudden death
  - Dyspnoa
  - Chest pain – classically pleuritic
  - Cough (haemoptysis is unusual)
  - Symptoms of DVT
  - Syncope (unlikely in isolation)

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ORIGINAL ARTICLE

Prevalence of Pulmonary Embolism among Patients Hospitalized for Syncope

Paolo Prandoni, M.D., Ph.D., Anthonie W.A. Lensing, M.D., Ph.D., Martin H. Prins, M.D., Ph.D., Maurizio Ciammaichella, M.D., Marica Perlati, M.D., Nicola Mumoli, M.D., Eugenio Bucherini, M.D., Adriana Visonà, M.D., Carlo Bova, M.D., Davide Imberti, M.D., Stefano Campostrini, Ph.D., and Sofia Barbar, M.D., for the PESIT Investigators*

N Engl J Med 2016; 375:1524-1531 | October 20, 2016 | DOI: 10.1056/NEJMoa1602172

ASSESSMENT

- Most patients will have dyspnea and/or chest pain
- Needs to be something you think about as a differential (can be easily forgotten)
- Mostly investigations focus on finding alternate cause for symptoms
- None of the initial investigations in isolation will make the diagnosis

INITIAL INVESTIGATIONS

Complete Initial Investigations:

☐ FBC ☐ U+E ☐ Creatinine ☐ LFTs ☐ Ca^{2+} ☐ β-HCG ☐ Coag hold+/-D-dimer

☐ CXR ☐ ECG ☐ Troponin‡ ☐ ABG if sats less than 92 %, ↑RR or clinical concern

There is no mandatory need for monitoring or telemetry unless there is clinical concern/ reason

Mostly investigations standard to patients with CP and SOB

- CXR
- ECG
- Bloods
- ABG (this is not needed in most settings)

Important to remember you can rule out a PE with no investigations in certain patients

ECG FINDINGS

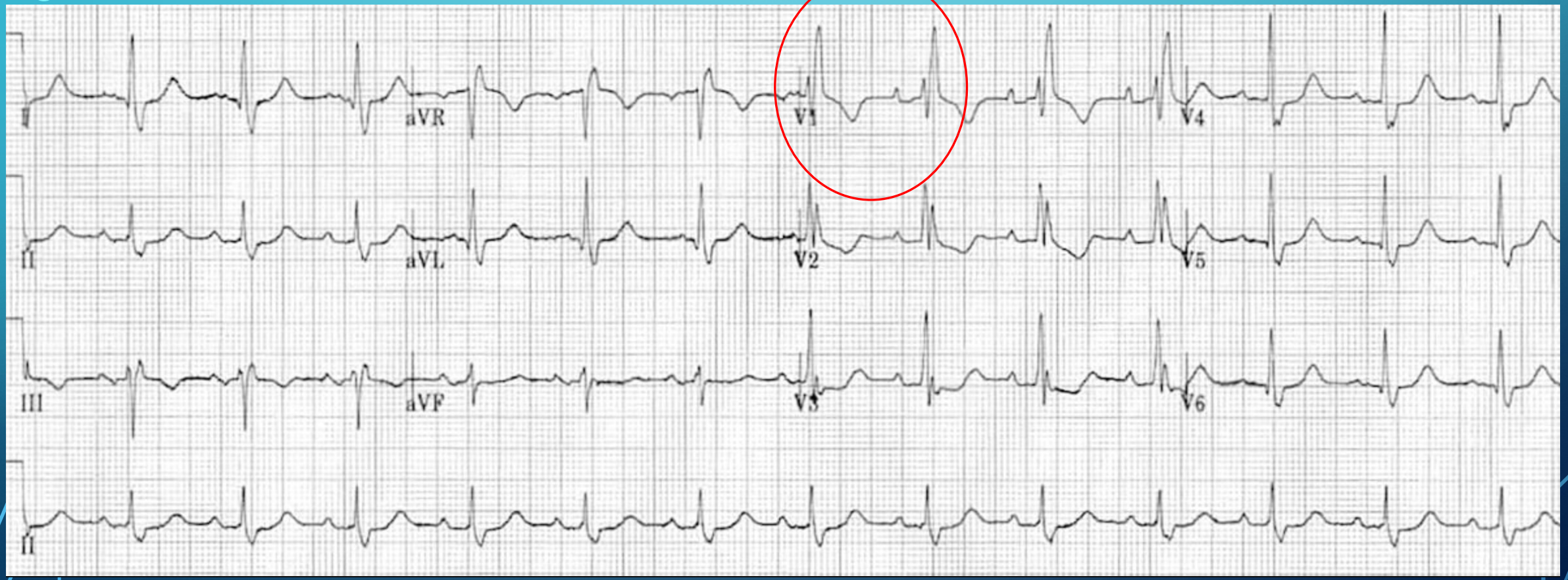
- Sinus tachycardia
- RBBB
- RV strain
- S1Q3T3

RIGHT BUNDLE BRANCH BLOCK (RBBB)

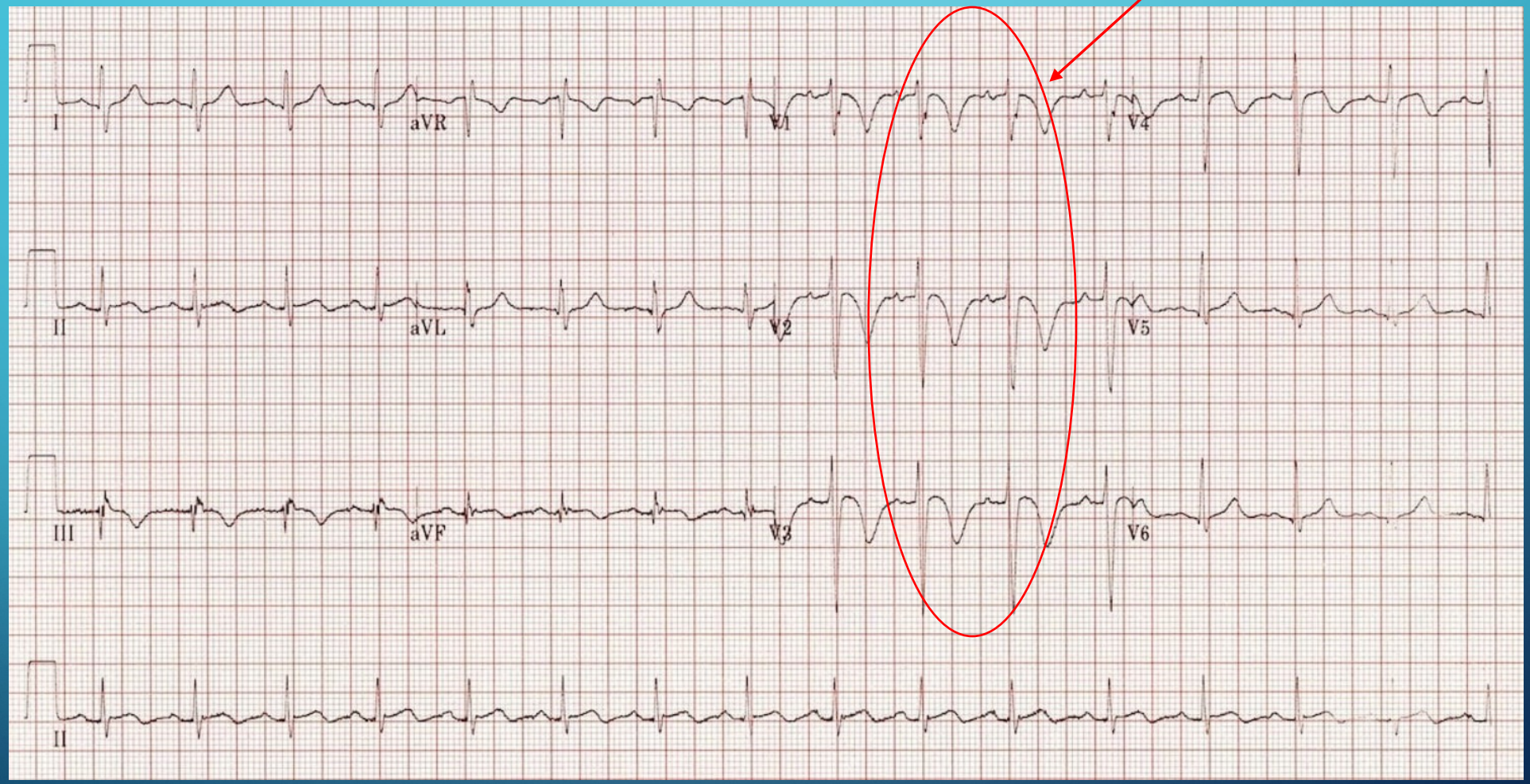
RSR'

Complete rbbb > 120 ms

Incomplete rbbb > 100ms



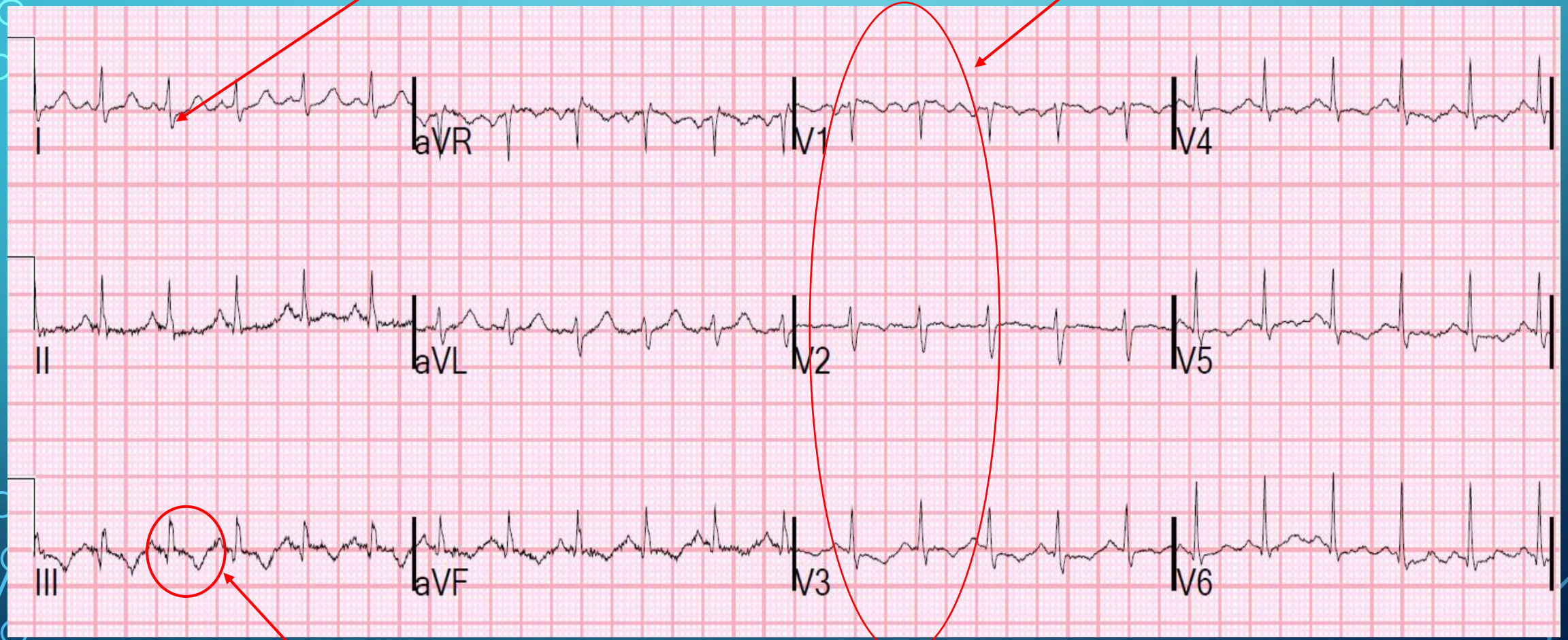
RV STRAIN


TWI in Ant precordial leads
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

S1Q3T3

Presence of S wave in lead I

When seen in conjunction with RV strain makes much more specific for PE



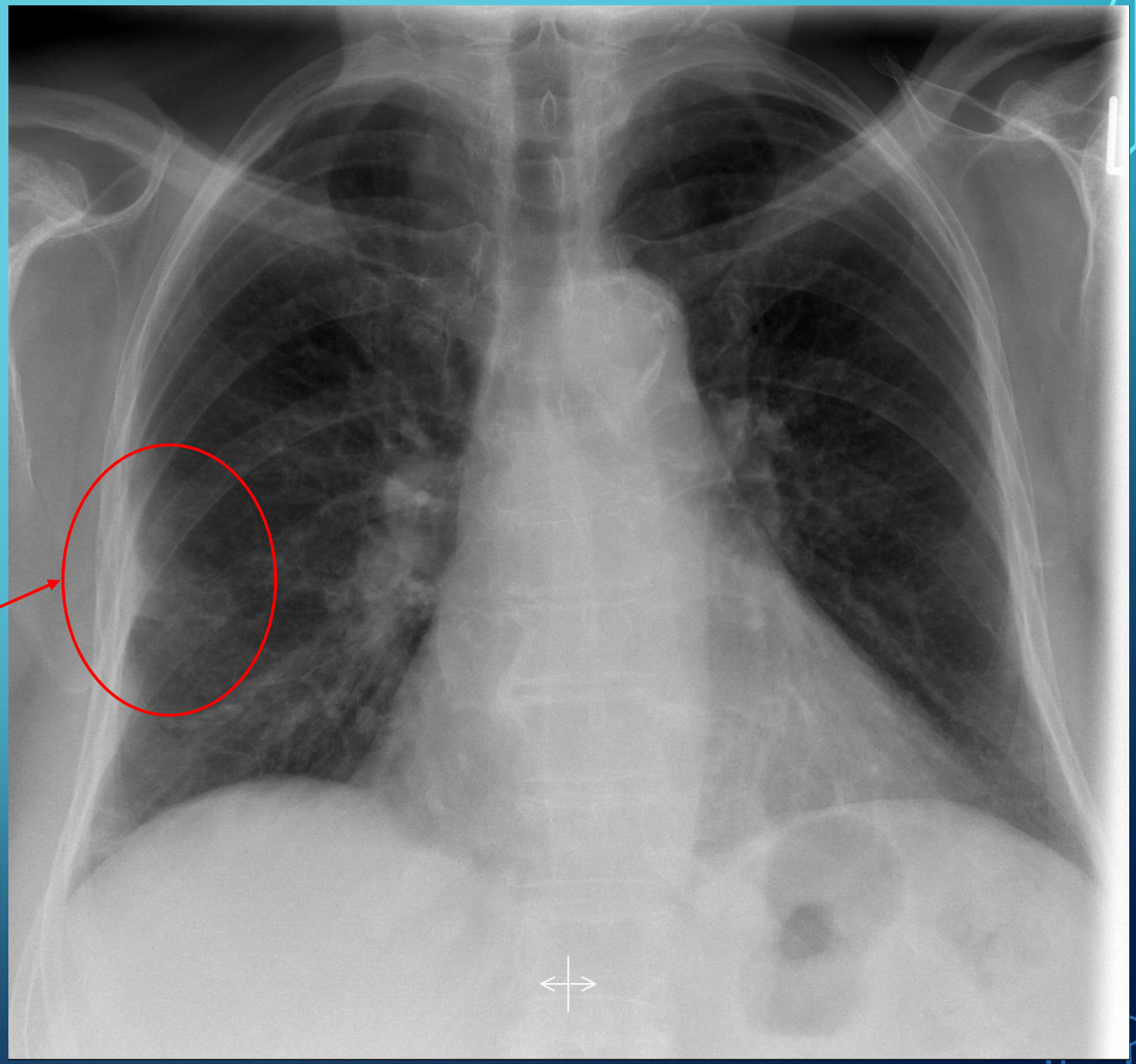
Q wave in 3

TWI in 3

CXR

Mostly doing to exclude alternative cause for Sx

- Pneumothorax
- Pneumonia
- CCF



Hampton Hump - pleural based wedge opacification from infarction

INITIAL WDHB PATHWAY

Pulmonary embolism needs to be excluded? *Rather than e.g. aortic dissection, IHD, pneumothorax, etc*

- ☐ Yes → Continue
- ☐ No → Exit pathway + manage appropriately

Does the patient have any exclusions?

- ☐ Pregnancy
- ☐ If patient already on anticoagulation discuss with Haematology
- ☐ No → Continue
- ☐ Yes → Exit pathway + manage appropriately

Is the patient haemodynamically stable?

- ☐ Yes → Continue
- ☐ No → Exit pathway + manage appropriately

Do you think the risk of PE is clinically low? *Is your gestalt impression that risk is less than 15%*

- ☐ Yes → Continue
- ☐ No → Move to Investigations Step

Is the PERC SCORE negative? *Please complete PERC on Concerto*

- ☐ No → Continue
- ☐ Yes → Exit pathway. Consider alternative†

IS THE RISK OF PE CLINICALLY LOW?

- Can be defined as low risk via
  - Clinical Gestalt
  - Well's score
  - Modified Geneva score

- ***Low risk is defined as risk of PE < 15%***

WELLS SCORE

- **Three-level scheme**
  - Low < 2 (1.3% risk)
  - Intermediate 2-6 (16.2% risk)
  - High >6 (37.5%)

- **Two-category scheme**
  - PE unlikely 0-4 points (12.1% risk)
  - PE likely >4 points (34% risk)

WELLS SCORE

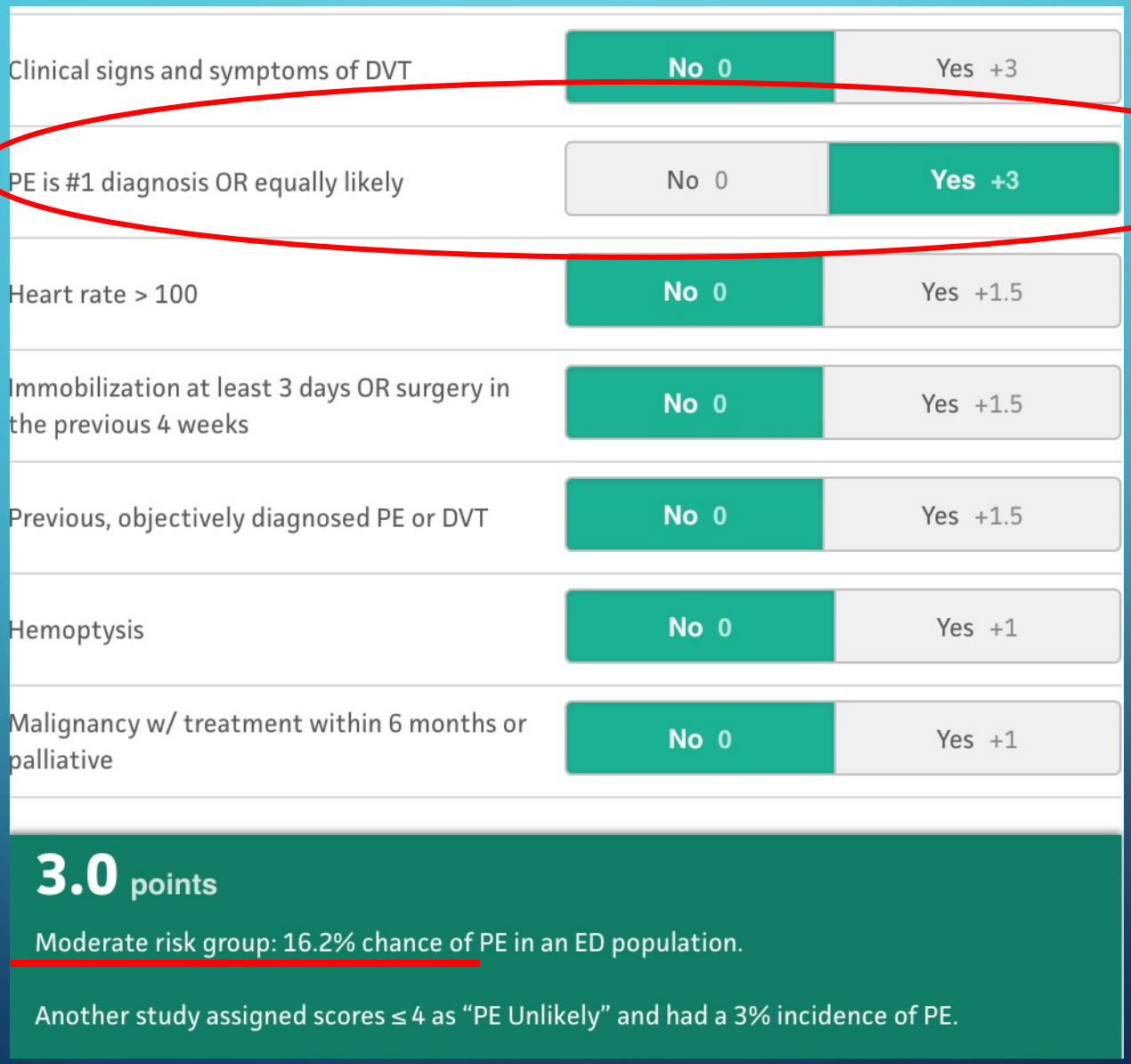
Clinical signs and symptoms of DVT	**No** 0	Yes +3
PE is #1 diagnosis OR equally likely	**No** 0	Yes +3
Heart rate > 100	**No** 0	Yes +1.5
Immobilization at least 3 days OR surgery in the previous 4 weeks	**No** 0	Yes +1.5
Previous, objectively diagnosed PE or DVT	**No** 0	Yes +1.5
Hemoptysis	**No**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

0.0 points

Low risk group: 1.3% chance of PE in an ED population.

Another study assigned scores ≤ 4 as “PE Unlikely” and had a 3% incidence of PE.

WELLS SCORE



SUBJECTIVE >15%

REVISED GENEVA SCORE

- The score obtained relates to probability of PE:
- 0 - 3 points indicates low probability (8%)
- 4 - 10 points indicates intermediate probability (29%)
- 11 points or more indicates high probability (74%)

REVISED GENEVA SCORE

Age > 65	**No** 0	Yes +1	
Previous DVT or PE	**No** 0	Yes +3	
Surgery (under general anesthesia) or lower limb fracture in past month	**No** 0	Yes +2	
Active malignant condition Solid or hematologic malignant condition, currently active or considered cured < 1 year	**No** 0	Yes +2	
Unilateral lower limb pain	**No** 0	Yes +3	
Hemoptysis	**No** 0	Yes +2	
Heart rate	**< 75** 0	75-94 +3	≥ 95 +5
Pain on lower limb palpation and unilateral edema	**No** 0	Yes +4	

0 points

Low risk group: 7-9% incidence of PE from several studies.

IF RISK OF PE IS CLINICALLY LOW

- **Apply the PERC rule**
- PERC = Pulmonary Embolism Rule out criteria
- Objective criteria
- All or nothing

PERC SCORE

Age ≥50	**No** 0	Yes +1
HR ≥100	**No** 0	Yes +1
O_2 sat on room air <95%	**No** 0	Yes +1
Unilateral leg swelling	**No** 0	Yes +1
Hemoptysis	**No** 0	Yes +1
Recent surgery or trauma Surgery or trauma ≤4 weeks ago requiring treatment with general anesthesia	**No** 0	Yes +1
Prior PE or DVT	**No** 0	Yes +1
Hormone use Oral contraceptives, hormone replacement or estrogenic hormones use in males or female patients	**No** 0	Yes +1

0 criteria

No need for further workup, as <2% chance of PE.

If no criteria are positive and clinician's pre-test probability is <15%, PERC Rule criteria are satisfied.

EQUIPOISE

"Equipoise is reached when the risk-benefit ratio of one course of action is balanced by the risk-benefit ratio of an alternative course of action"

HEART RATE > 100

- Although not stipulated in initial PERC study should use the most abnormal vital sign – whether that be triage or in dept.
- B-blockers – can we include patients on these?

PERC POSITIVE

Age ≥50	**No 0**	Yes +1
HR ≥100	No 0	**Yes +1**
O_2 sat on room air <95%	**No 0**	Yes +1
Unilateral leg swelling	**No 0**	Yes +1
Hemoptysis	**No 0**	Yes +1
Recent surgery or trauma Surgery or trauma ≤4 weeks ago requiring treatment with general anesthesia	**No 0**	Yes +1
Prior PE or DVT	**No 0**	Yes +1
Hormone use Oral contraceptives, hormone replacement or estrogenic hormones use in males or female patients	**No 0**	Yes +1

1 criteria

If any criteria are positive, the PERC rule cannot be used to rule out PE in this patient.

THEN APPLY THE WELLS SCORE

- We use two level Well score
  - 0-4 “PE Unlikely”
  - >4 “PE Likely”

- If “PE Unlikely” check a D-dimer
- If ”PE Likely” move straight to CTPA

WDHB PATHWAY

What is the Wells Score? *Please complete Wells score on Concerto*

- ☐ 0 - 4 *"PE Unlikely"*
- ☐ 4 and above *"PE Likely"* Move to CTPA Step

▼

Check D-DIMER. Is it positive?

- ☐ Yes → Continue
- ☐ No → Exit pathway unless high clinical concern

▼

Request CTPA. *All requests must be discussed with the on call radiology team*

- ☐ **NSH location**: CTPA on day of request in less than 2hrs
- ☐ **WTH location**: CTPA Mon- Fri, 8am-4pm Except under exceptional circumstances Otherwise either next day scan or transfer NSH

D-DIMER

- Degradation product of fibrin (reflective of clot burden)
- Highly sensitive = few false negative
- Poor specificity = lots of false positive
- Typical negative < 500 ug/L
- Age adjusted levels – by doing this makes test use more specific

AGE ADJUSTED

- Age < 50 = < 500
- Age < 60 = < 600
- Age < 70 = < 700
- Age < 80 = < 800

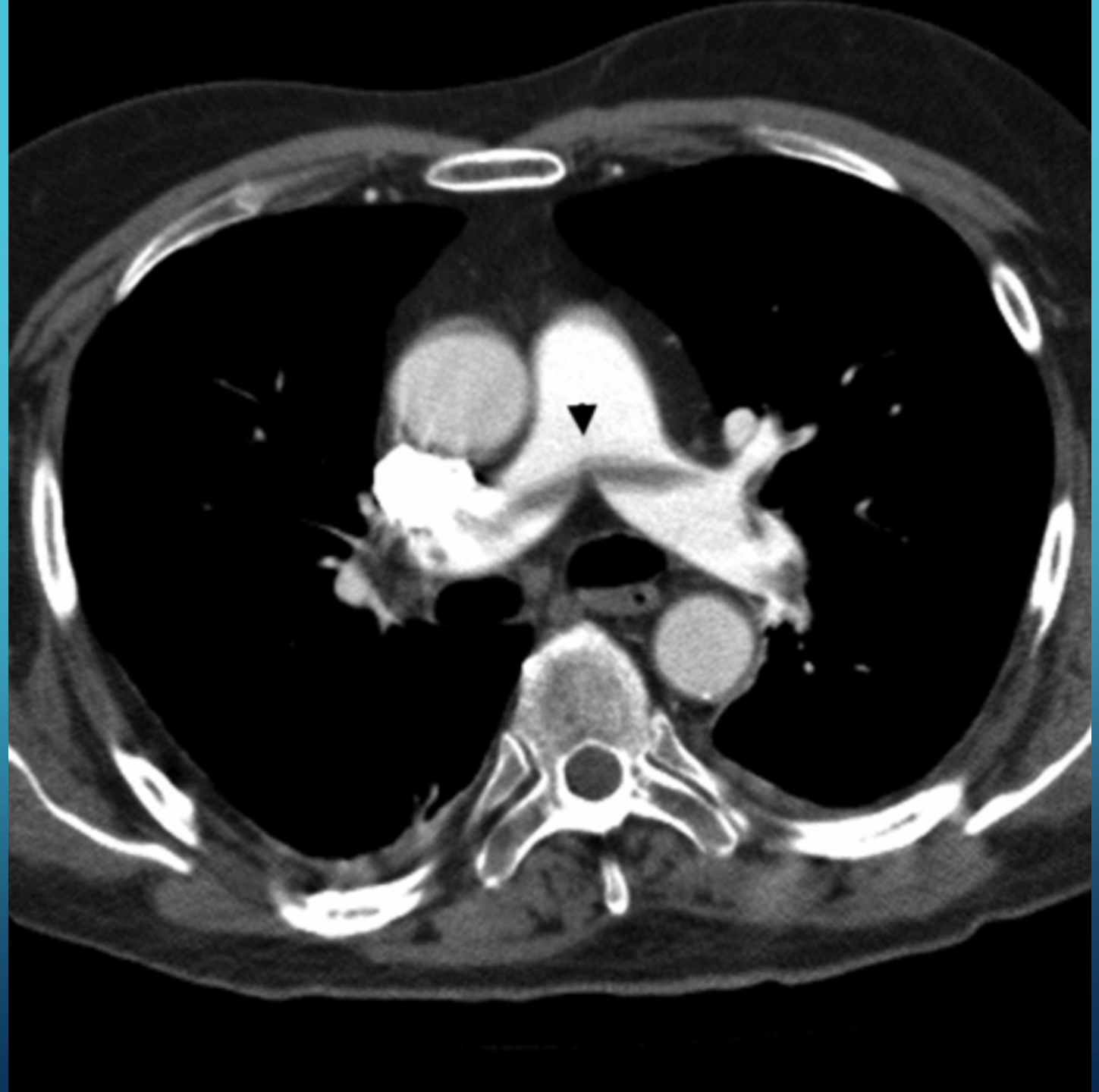
Adjusted D-dimer = age x 10 (once over the age of 50)

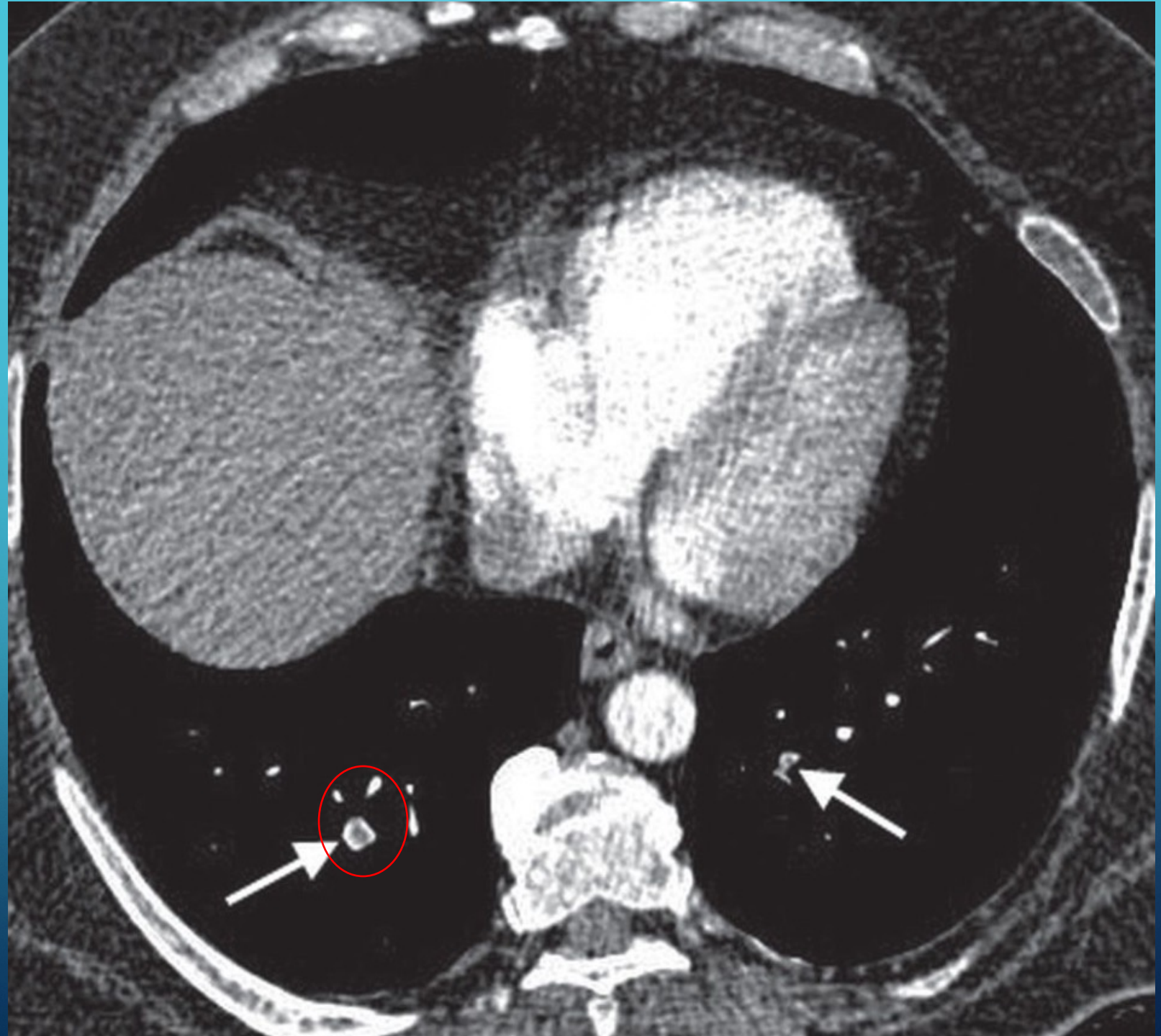
IMAGING OPTIONS

- CTPA
- V/Q scan
- Ultrasound of the lower limbs
- Echo

CT PULMONARY ANGIOGRAM

Pros	Cons
Quick and accessible	Radiation dose - Around 400 x CXR - Younger the patient the greater risk radiation cancer - 1/4000 in 35 year old (lifetime cancer DEATH)
Sensitivity 85% Specificity 96% (still 4% false positive)	Contrast nephropathy Allergic reaction
Can give information about RV strain and effect on heart also	Detects small insignificant clot - Small subsegmental - Can result in inappropriate anticoagulation



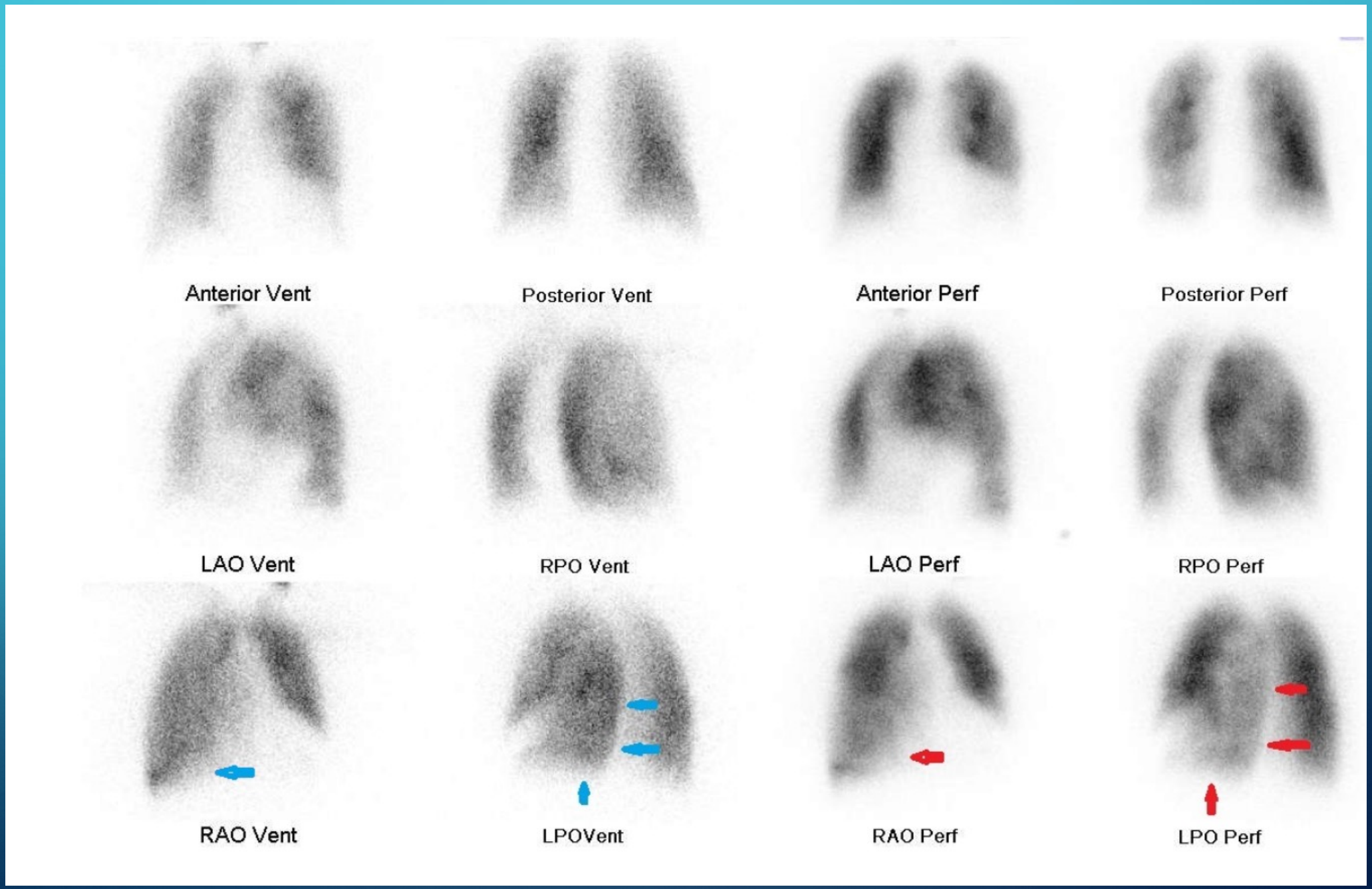


VENTILATION/PERFUSION SCAN (V/Q)

- Two parts to the scan

1. Radioactive material breathed in (ventilation)
2. Radioactive material injected into the arm (perfusion)

Pros	Cons
Lower radiation dose than CTPA (esp breast)	Takes long time
Less contrast nephropathy	Only available at ADHB
Perfusion only scans	Indeterminate results common


Anterior Vent
Posterior Vent
Anterior Perf
Posterior Perf
LAO Vent
RPO Vent
LAO Perf
RPO Perf
RAO Vent
LPOVent
RAO Perf
LPO Perf

LOWER LIMB ULTRASOUND

- May be considered in certain patients where can't perform CT imaging due to concern about renal function or radiation load
- If symptoms of PE and + USS showing proximal DVT

Pros	Cons
Cheap, accessible	Does not rule out PE
No radiation	Doesn't give information about location etc
Can be done at bedside by ED SMO	Not good for DVT's in pelvis

TRANSTHORACIC ECHO

Pros	Cons
Can be performed at bedside (helpful in unstable patients)	Can't confirm diagnosis
No radiation	Operator and patient dependent
Information about RV strain/Pulm HTN	Does not exclude PE (poorly sensitive)

CTPA-BASED MANAGEMENT OF CONFIRMED PE

Perform CTPA – is CTPA positive? *Use the provisional report if final not available same day*
All patients should be under care of General Medicine at this stage

- ☐ **Yes →** Continue
- ☐ **No →** Exit pathway + manage appropriately

▼

Does CTPA show high-risk features?

- ☐ Large clot burden / multi-lobe involvement
- ☐ Saddle embolus
- ☐ RV dilation/strain

- ☐ **No →** Continue
- ☐ **Yes →** See **BOX 3** below

▼

Is the patient suitable for outpatient management? *Check against criteria in **BOX 1** above*

- ☐ **Yes →** GM to arrange discharge
  see below for investigations and treatment
- ☐ **No →** GM to arrange admission
  see below for investigations and treatment

TREATMENT MODALITIES

- Aside from patients with Massive/High risk PE's who exhibit haemodynamic instability most patients simply are given CLEXANE
  - 1mg/kg BD (up to max 200mg BD)
  - Reduce to 1mg/kg OD if CrCl < 30ml/min or weight < 45kg

They are then started on either Warfarin (initially) or Dabigatran (on day 6)

THROMBOLYSIS

- Indicated in Massive PE/High risk PE
  - Haemodynamic instability
  - Cardiogenic shock
  - Cardiac arrest presumed due to PE (usually PEA)
- Clexane should not be withheld pending CTPA if high clinical suspicion
- Decision via ICU/ED/Resp consultant
- Tenectaplase + Heparin (bolus then infusion)

HOT OFF THE PRESS

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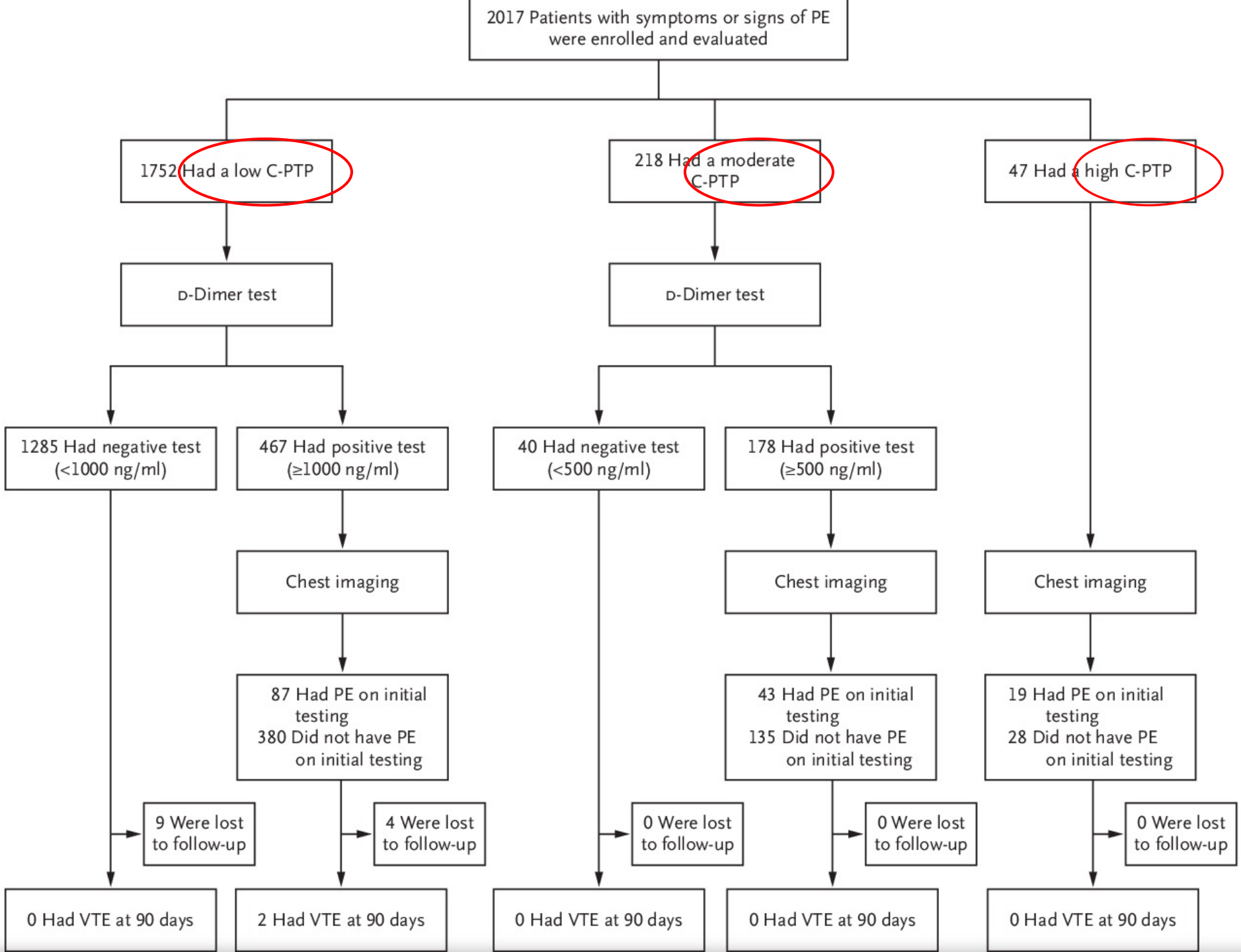
ORIGINAL ARTICLE

Diagnosis of Pulmonary Embolism with D-Dimer Adjusted to Clinical Probability

Clive Kearon, M.B., Ph.D., Kerstin de Wit, M.B., Sameer Parpia, Ph.D., Sam Schulman, M.D., Ph.D., Marc Afilalo, M.D., Andrew Hirsch, M.D., Frederick A. Spencer, M.D., Sangita Sharma, M.D., Frédérick D'Aragon, M.D., Jean-François Deshaies, M.D., Gregoire Le Gal, M.D., Ph.D., Alejandro Lazo-Langner, M.D., Cynthia Wu, M.D., Lisa Rudd-Scott, R.N., Shannon M. Bates, M.D., and Jim A. Julian, M.Math., for the PEGeD Study Investigators*


2017 Patients with symptoms or signs of PE were enrolled and evaluated
1752 Had a low C-PTP
218 Had a moderate C-PTP
47 Had a high C-PTP
D-Dimer test
D-Dimer test
1285 Had negative test (<1000 ng/ml)
467 Had positive test (≥1000 ng/ml)
40 Had negative test (<500 ng/ml)
178 Had positive test (≥500 ng/ml)
Chest imaging
Chest imaging
Chest imaging
87 Had PE on initial testing
380 Did not have PE on initial testing
43 Had PE on initial testing
135 Did not have PE on initial testing
19 Had PE on initial testing
28 Did not have PE on initial testing
9 Were lost to follow-up
4 Were lost to follow-up
0 Were lost to follow-up
0 Were lost to follow-up
0 Were lost to follow-up
0 Had VTE at 90 days
2 Had VTE at 90 days
0 Had VTE at 90 days
0 Had VTE at 90 days
0 Had VTE at 90 days