

# **PULMONARY EMBOLISM: DIAGNOSIS AND TREATMENT**

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## **OUTLINE**

- **DIAGNOSIS OF PE**
- **CLINICAL DECISION RULES**
- **CLINICAL TESTS**
- **DIAGNOSTIC IMAGING**
- **TREATMENT**
- **CONTROVERSIES IN MANAGEMENT/CUTTING EDGE**

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# DISCLOSURE

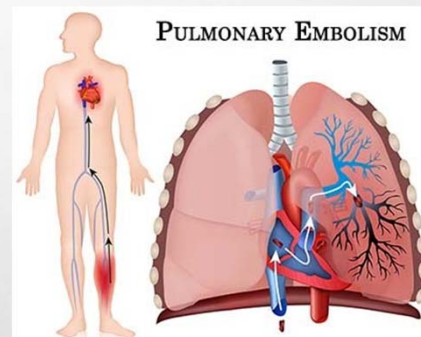
- I TAKE NO MONEY FROM ANY COMPANIES
- ...BUT I'M VERY WILLING, IF YOU KNOW ANYONE!



3

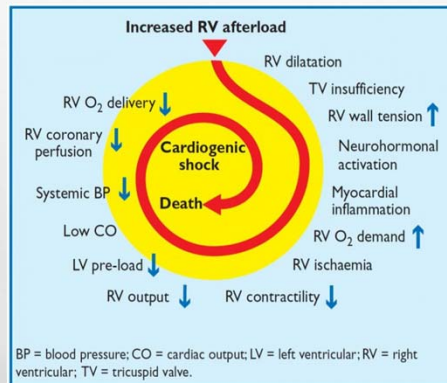
# PULMONARY EMBOLISM

- CLOTTED BLOOD ENTERING PULMONARY CIRCULATION
- OFTEN ORIGINATES FROM DEEP VEINS OF THE LEGS (DVT)



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# PULMONARY EMBOLISM



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# PULMONARY EMBOLISM

- IT'S BAD
- IT'S COMMON
- IT'S TRICKY TO DIAGNOSE
- WE STILL SOMEHOW MANAGE TO OVER-TEST FOR IT

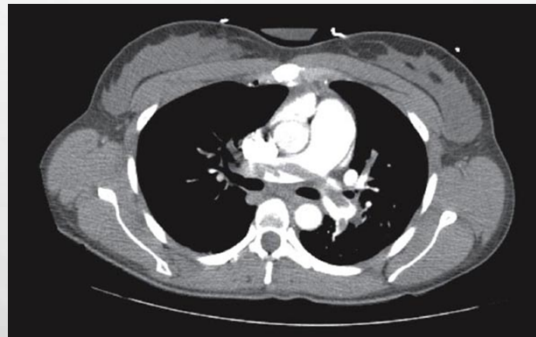
6

## WHO SHOULD BE EVALUATED?

- DYSPNEA
- COUGH
- CHEST PAIN
- SYNCOPES\*
  - PESIT TRIAL

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## RISK FACTORS



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# RISK FACTORS



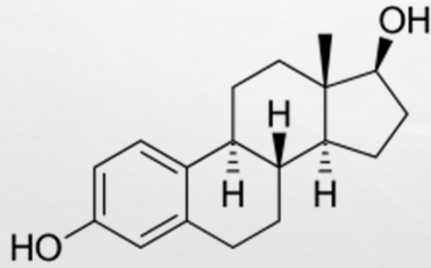
9

# RISK FACTORS



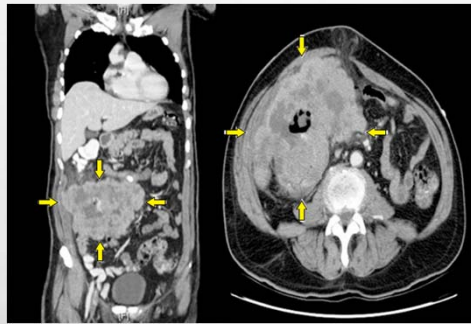
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# RISK FACTORS



11

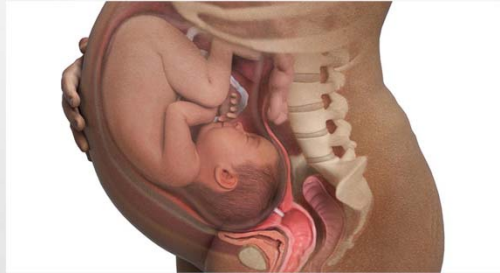
# RISK FACTORS



12

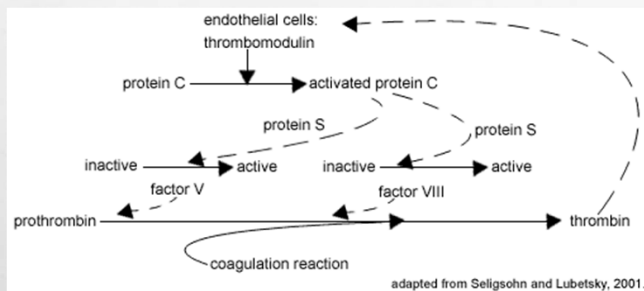


# RISK FACTORS



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# RISK FACTORS



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## PHYSICAL EXAM

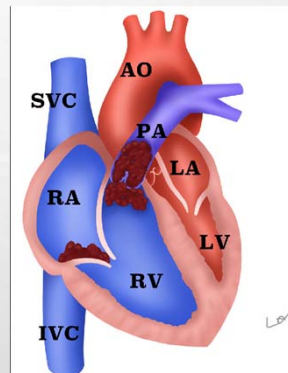
- NORMAL!
- TACHYCARDIA
- HYPOXIA
- TACHYPNEA
- SIGNS OF DVT



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## EVALUATION FOR PE - ECG

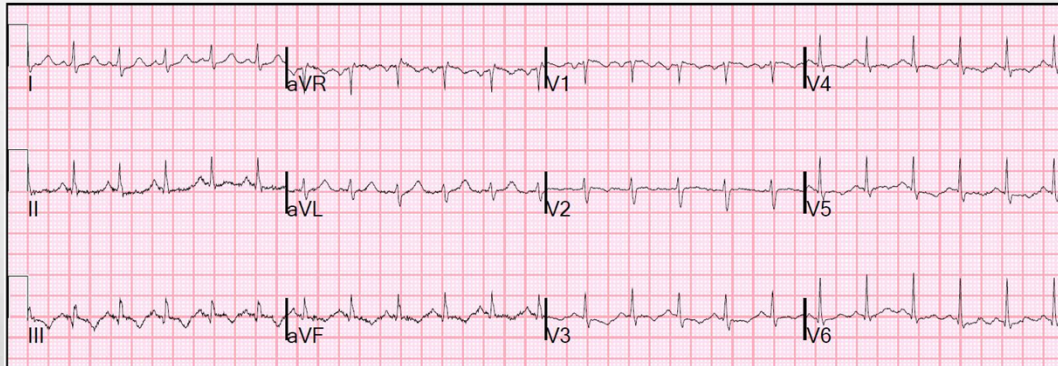
- SINUS TACHYCARDIA
- RIGHT HEART STRAIN PATTERNS



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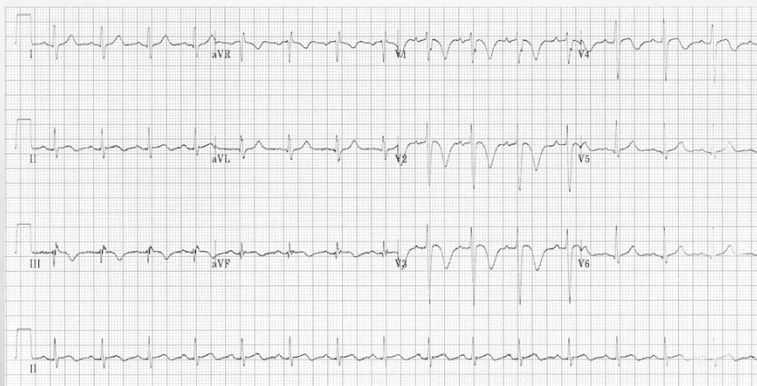


## EVALUATION FOR PE - ECG



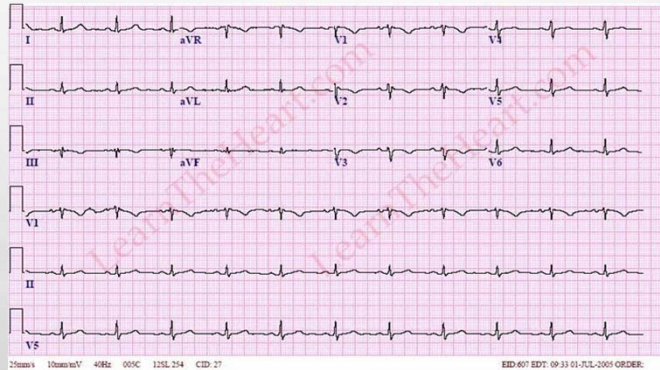
17

## EVALUATION FOR PE - ECG



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## EVALUATION FOR PE - ECG



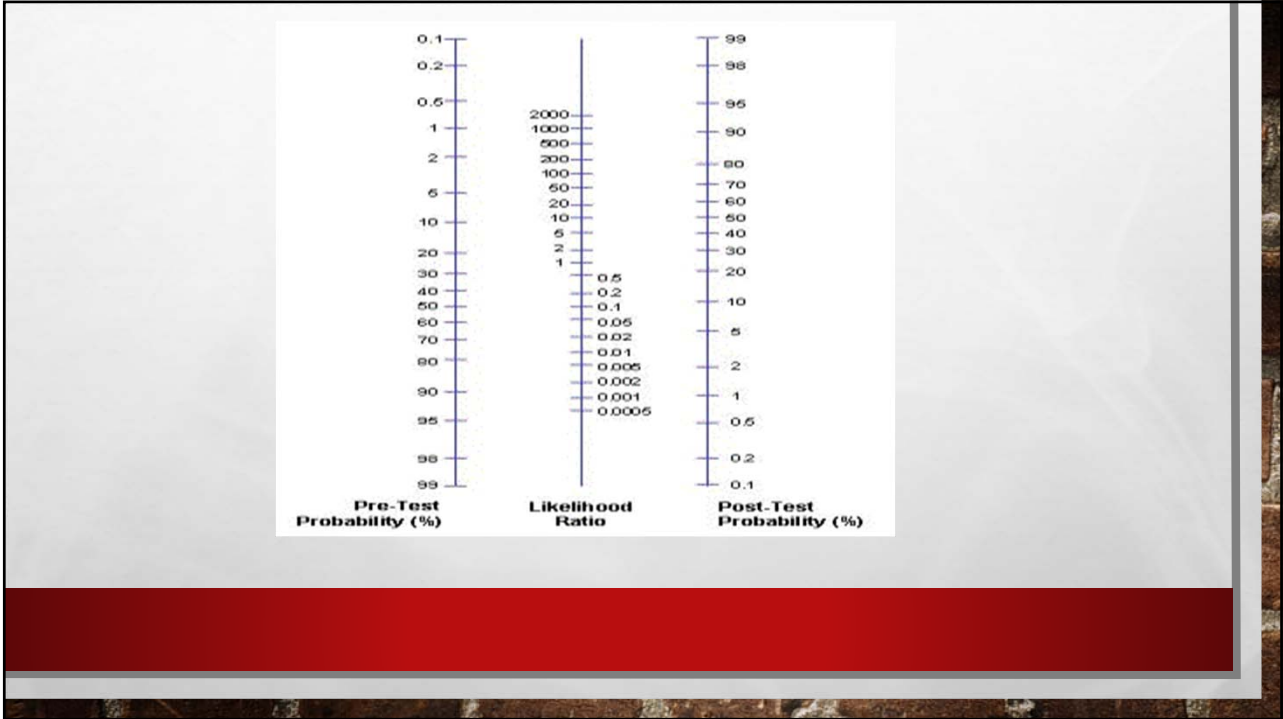
19

## EVALUATION FOR PE - CXR

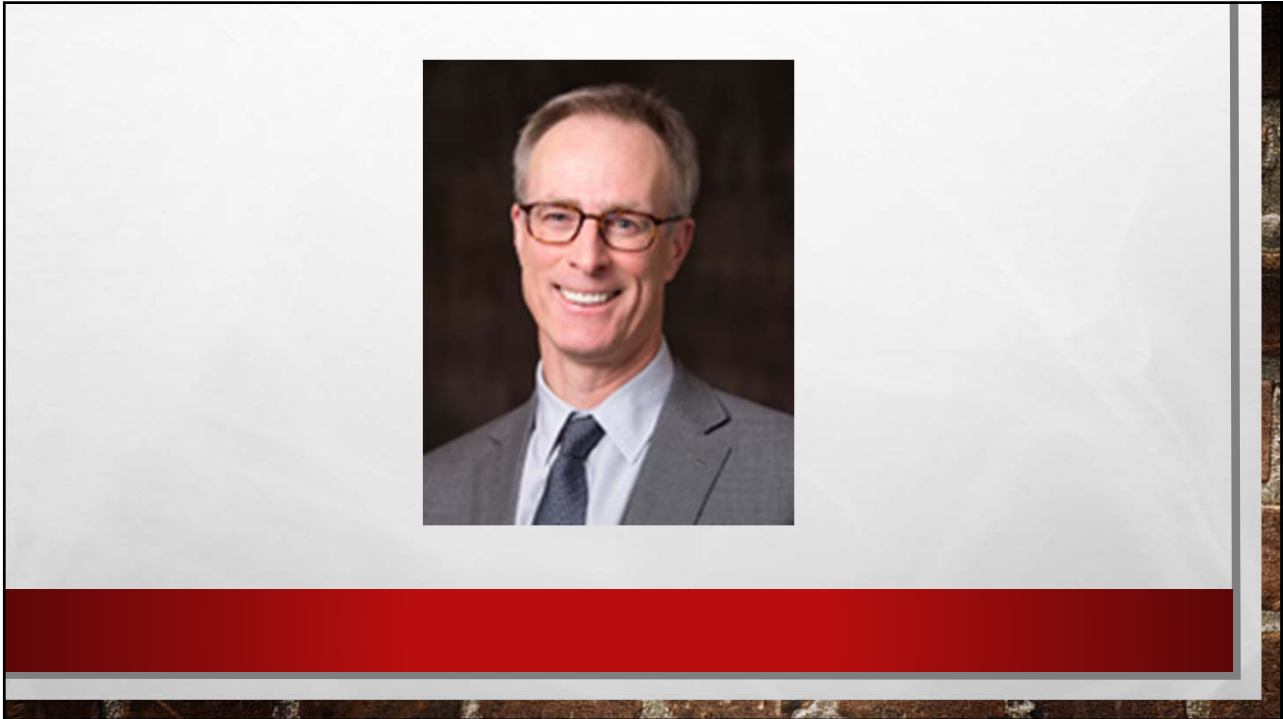
- USEFUL FOR GENERATING ALTERNATIVE DIAGNOSES
- BEWARE PULMONARY INFARCT



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# WELLS CRITERIA

3:55 Wells' Score for PE

CALCULATOR NEXT STEPS EVIDENCE CREATOR

Clinical signs and symptoms of DVT  No  Yes +3

PE is #1 diagnosis OR equally likely  No  Yes +3

Heart rate > 100  No  Yes +1.5

Immobilization at least 3 days OR surgery in the previous 4 weeks  No  Yes +1.5

Previous, objectively diagnosed PE or DVT  No  Yes +1.5

RESULT **0.0 points** Low Risk

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Hemoptysis  No  Yes -1

Malignancy w/ treatment within 6 months or palliative  No  Yes -1

RESULT **0.0 points** Low Risk

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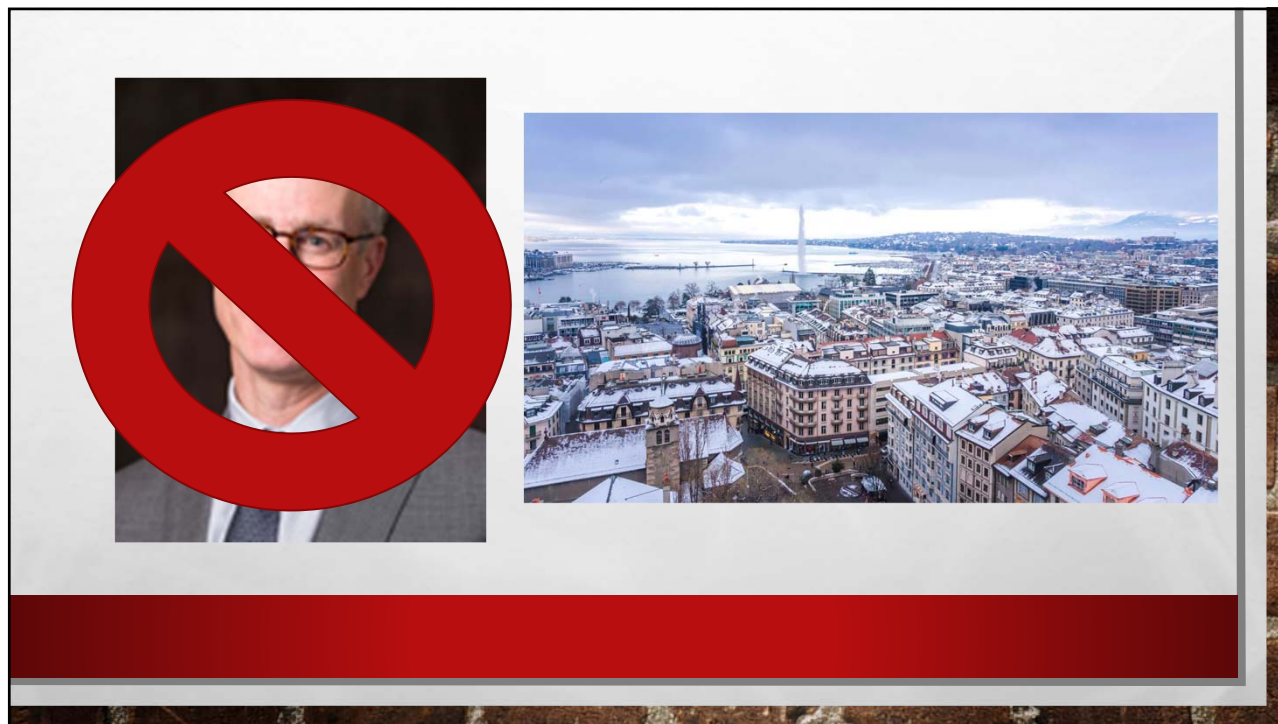
Hemoptysis  No  Yes -1

Malignancy w/ treatment within 6 months or palliative  No  Yes -1

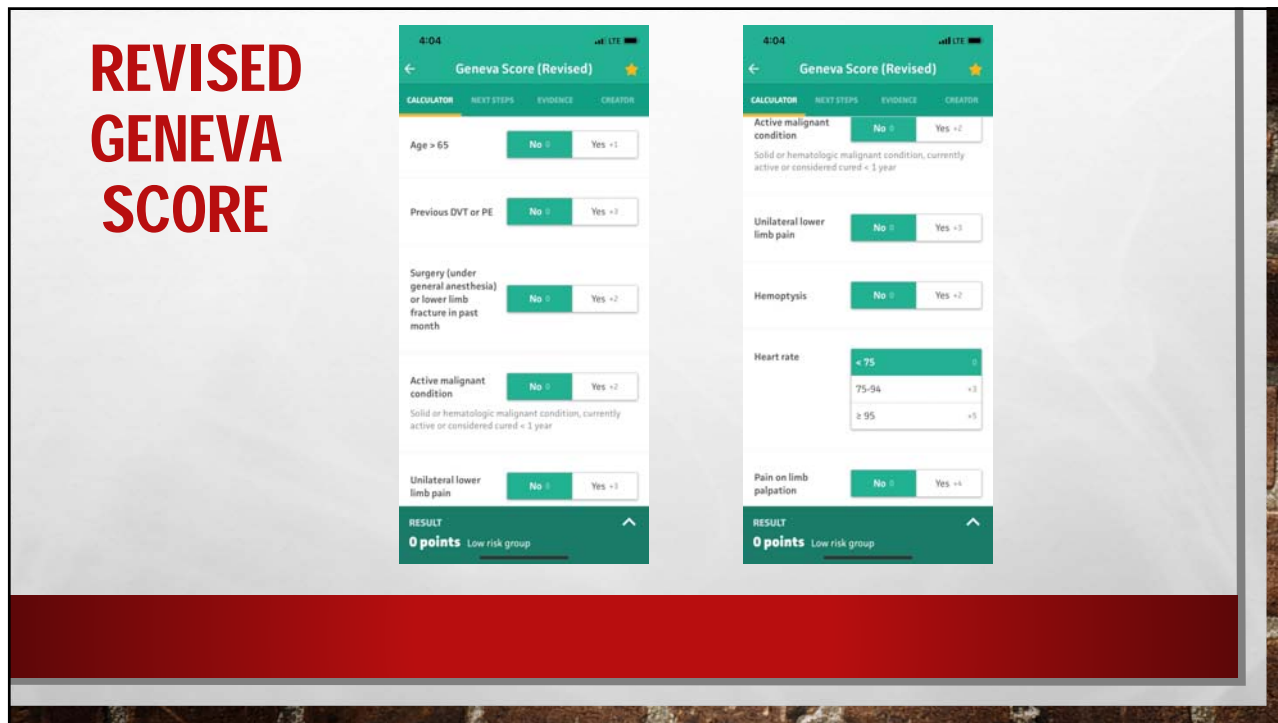
RESULT **0.0 points** Low Risk

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## EVALUATION FOR PE – D DIMER



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## EVALUATION FOR PE – D DIMER

- **THREE STEP PROCESS:**
  - DO I REALLY THINK THIS PATIENT HAS A PE?
  - NO, BUT REALLY?
  - AM I GOING TO BE HAPPY ACTING ON A POSITIVE D-DIMER?
- D DIMER SHOULD BE USED *IN CONJUNCTION WITH CLINICAL DECISION TOOLS* TO SCREEN FOR PE
- D DIMER BEING POSITIVE DOES *NOT* OBLIGATE YOU TO PERFORM FURTHER IMAGING

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## CLINICAL DECISION TOOLS

LOW OR MEDIUM RISK BY SCORING SYSTEM

D- Dimer Negative

STOP EVALUATING FOR PE

D- Dimer Positive

HIGH RISK BY SCORING SYSTEM

Don't pass go, just

PERFORM ADDITIONAL PE TESTING

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## AGE ADJUSTED D DIMER

- D DIMER LEVELS NATURALLY RISE WITH AGE
- MULTIPLE STUDIES ON ADJUSTING THE UPPER LIMIT OF NORMAL BASED ON AGE
  - SCHOUTEN (2013) – 97% SENSITIVE
  - RIGHINI (2014) – INCREASED SPECIFICITY WITHOUT CHANGING SENSITIVITY
  - VAN ES (2016) – 5-15% DECREASED PE IMAGING; NO RISK OF MISS
  - APPLY IN PEOPLE >50



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## AGE ADJUSTED D DIMER

- **IN D DIMER ASSAY WHERE NORMAL IS <500 NG/ML (FEU)**
  - **NEW UPPER LIMIT OF NORMAL IS (PATIENTS AGE X 10)**
    - **EG – 65 YEAR OLD NEW NORMAL IS <650 NG/ML**
- **IN D DIMER ASSAY WHERE NORMAL IS <250 NG/ML (DDU)**
  - **NEW UPPER LIMIT OF NORMAL IS (PATIENT'S AGE X 5)**
    - **EG – 65 YEAR OLD NEW NORMAL IS <325 NG/DL**
- **IN D DIMER ASSAY WHERE NORMAL IS <230 NG/ML.....PRAY?**

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## AGE ADJUSTED D DIMER

- **REDUCED PE TESTING AROUND 15%**
- **LESS THAN 2% MISS RATE**
- **SUPPORTED BY ACEP**
- **IN THROMBOSIS CANADA GUIDELINES**

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## PULMONARY EMBOLISM RULE OUT CRITERIA

- CRITERIA TO BE APPLIED IN LOW RISK PATIENTS
- CAN RULE OUT\* PE IF ALL ELEMENTS ARE NEGATIVE



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## PERC RULE

- PATIENT HAS TO BE LOW RISK (<15% RISK)
  - WELLS
  - GENEVA
  - GESTALT
- THEN APPLY THE CRITERIA
- IF ALL ARE NEGATIVE – STOP YOUR WORK UP FOR PE!

**PERC Rule for Pulmonary Embolism**

Rules out PE if all criteria are present and pre-test probability is <15%.

Age > 50	<input type="checkbox"/> NO	<p>No need for further workup, as &lt;2% chance of PE.</p> <p>If no criteria are positive and clinician's pre-test probability is &lt;15%, PERC Rule criteria are satisfied.</p>
HR ≥ 100	<input type="checkbox"/> NO	
O2 Sat on Room Air < 95%	<input type="checkbox"/> NO	
Prior History of DVT/PE	<input type="checkbox"/> NO	
Recent Trauma or Surgery	<input type="checkbox"/> NO	
Hemoptysis	<input type="checkbox"/> NO	
Exogenous Estrogen	<input type="checkbox"/> NO	
Unilateral Leg Swelling	<input type="checkbox"/> NO	

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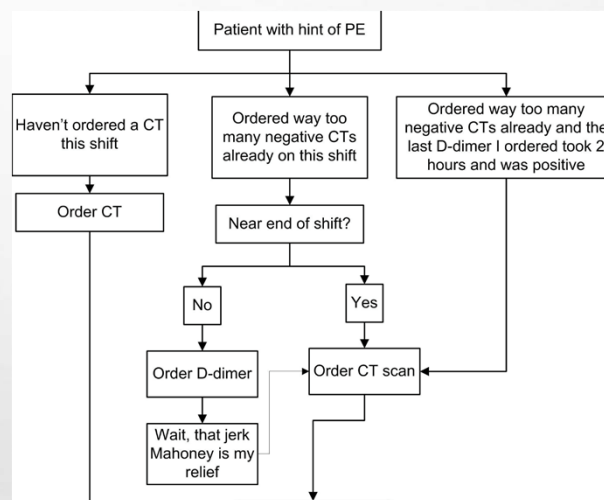
## PERC RULE

- **PROPER TRIAL (FREUND 2018)**
  - **ONE MISSED PE BY USING CRITERIA**
- **ACEP (2018) – LEVEL B RECOMMENDATION**
- **ALSO IN THROMBOSIS CANADA GUIDELINES**

In patients with low clinical probability of PE, and in the absence of D-dimer assay testing, the diagnosis can be safely excluded using the PERC (Pulmonary Embolism Rule-out Criteria) rule for pulmonary embolism.

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## IMAGING IN PE

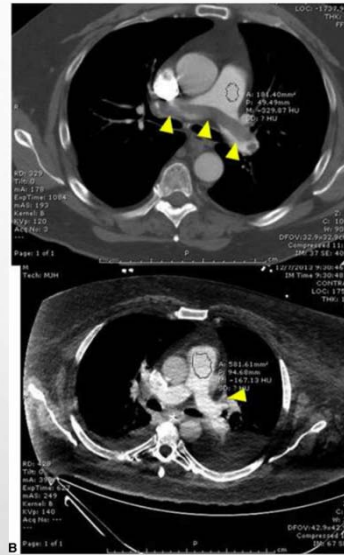


Courtesy Jeffrey Kline

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# CT SCAN

- CT PULMONARY ANGIOGRAPHY
- ABOUT 90% SENSITIVE
- NEED AT LEAST 200 HU IN MAIN PULMONARY ARTERIES



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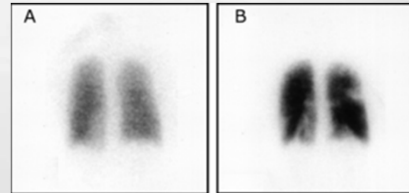
# CT SCAN

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• <b>ADVANTAGES</b> <ul style="list-style-type: none"> <li>• MORE READILY AVAILABLE</li> <li>• CAN SHOW OTHER LUNG PATHOLOGY</li> <li>• QUICKER</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• <b>DISADVANTAGES</b> <ul style="list-style-type: none"> <li>• <b>CONTRAST</b> <ul style="list-style-type: none"> <li>• KIDNEY INJURY</li> <li>• ALLERGY</li> <li>• EXTRAVASATION</li> </ul> </li> <li>• RADIATION DOSE</li> <li>• FALSE POSITIVES</li> </ul> </li> </ul> |
|---|---|

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## VENTILATION/PERFUSION SCAN (V/Q)

- INHALATION OF RADIOACTIVE TECHNETIUM OR XENON ISOTOPE
- SUBSEQUENT IV INJECTION OF RADIOACTIVE TECHNETIUM
- CHEST SCANNED TO SEE VENTILATION AND PERFUSION
- MISMATCH IMPLIES PE



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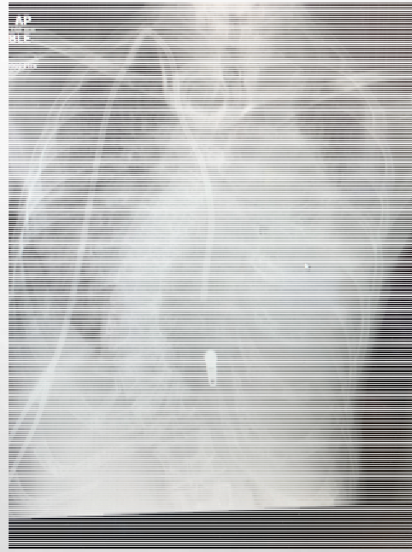
## V/Q SCAN

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• <b>ADVANTAGES</b> <ul style="list-style-type: none"> <li>• LOWER RADIATION DOSE</li> <li>• NO RENAL INVOLVEMENT</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• <b>DISADVANTAGES</b> <ul style="list-style-type: none"> <li>• AVAILABILITY</li> <li>• INTERPRETATION</li> <li>• NEED NORMAL LUNGS</li> </ul> </li> </ul> |
|---|---|

40



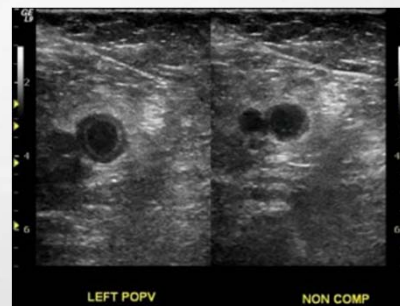
## WHAT TO DO?



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## DUPLEX ULTRASONOGRAPHY

- ULTRASOUND LOOKING AT DEEP VEINS OF THE LEG
- CAN BE SOURCE OF PE
- PERFORMANCE?
  - SENSITIVITY: 30%
  - SPECIFICITY: 57%
- IF POSITIVE TREAT FOR SUSPECTED PE
- MAY BE SUPPLEMENTARY TEST IN HIGH RISK PT WITH POOR SCANS



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## RURAL AND REMOTE



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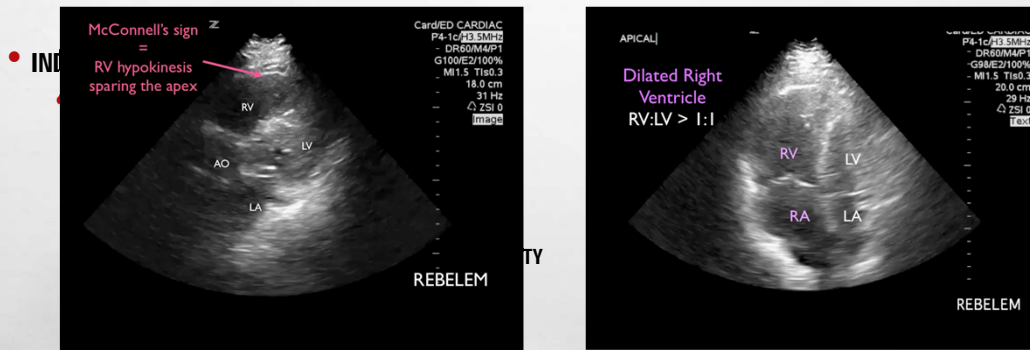
## BEDSIDE ULTRASOUND AND PE

- CAN WE USE ULTRASOUND TO HELP DIAGNOSE PE?
  - INDIRECT SIGNS?
  - DIRECT SIGNS?



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## BEDSIDE ULTRASOUND IN PE



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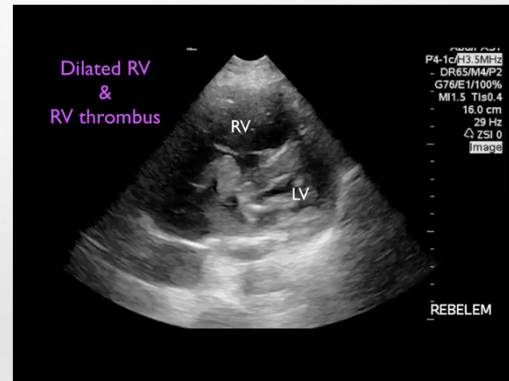
## BEDSIDE ULTRASOUND IN PE

- **MINIATI (2001)**
  - POSITIVE SCAN = RV HYPOKINESIS, RV SIZE, TRICUSPID REGURGITATION
  - SENSITIVE 53%, SPECIFICITY 90%
- **DRESDEN (2014)**
  - POSITIVE SCAN = RV DILATION
  - 98% SPECIFIC FOR PE

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## BEDSIDE ULTRASOUND IN PE

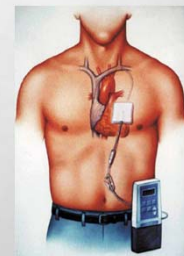
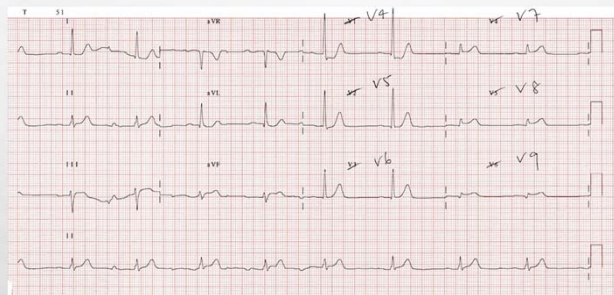
- **THROMBUS IN TRANSIT**
  - CLOT VISUALIZED IN THE RV
  - HIGHLY PREDICTIVE OF PE
  - HIGHER MORTALITY
  - SICKER PATIENTS



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## BEDSIDE ULTRASOUND IN PE

- **PROBLEMS?**
  - MIMICS!
  - SKILLS



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## BEDSIDE ULTRASOUND IN PE

- ACEP/AMERICAN SOCIETY OF ECHOCARDIOGRAPHY
  - "MAY BE HELPFUL IF POSITIVE IN THE COMPROMISED PATIENT BUT IS CLEARLY NOT SUFFICIENT TO RULE THIS IMPORTANT DIAGNOSIS OUT OR TO RISK STRATIFY PATIENTS WITH **STABLE HEMODYNAMICS**"
- EUROPEAN SOCIETY OF CARDIOLOGY
  - " IN A HAEMODYNAMICALLY COMPROMISED PATIENT WITH SUSPECTED PE, UNEQUIVOCAL SIGNS OF RV PRESSURE OVERLOAD AND DYSFUNCTION JUSTIFY EMERGENCY REPERFUSION TREATMENT FOR PE IF IMMEDIATE CT ANGIOGRAPHY IS NOT FEASIBLE"

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## BEDSIDE ULTRASOUND IN PE

- DVT STUDY
  - MAY BE HELPFUL IN RULING IN A CLOT
  - SAME CAVEATS AS BEFORE

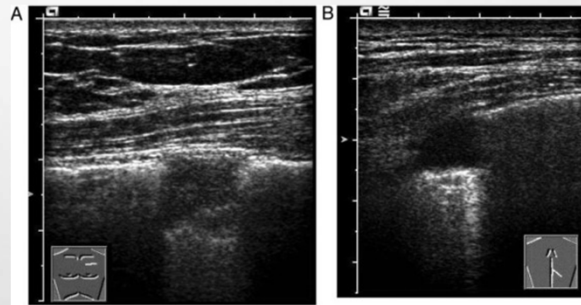


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## BEDSIDE ULTRASOUND IN PE

- DIRECT SIGNS
  - PULMONARY CONSOLIDATION
    - INFARCT
    - ATELECTASIS
- SQUIZZATTO (2013)
  - META-ANALYSIS OF STUDIES LOOKING AT US IN PE
  - POOLED SENSITIVITY OF 81% AND SPECIFICITY OF 89%
- MATHIS (2015)
  - 2 PLEURAL LESIONS –OR–
  - 1 PLEURAL LESION AND PLEURAL EFFUSION
  - SPECIFICITY 95%-99%



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## BEDSIDE ULTRASOUND IN PE

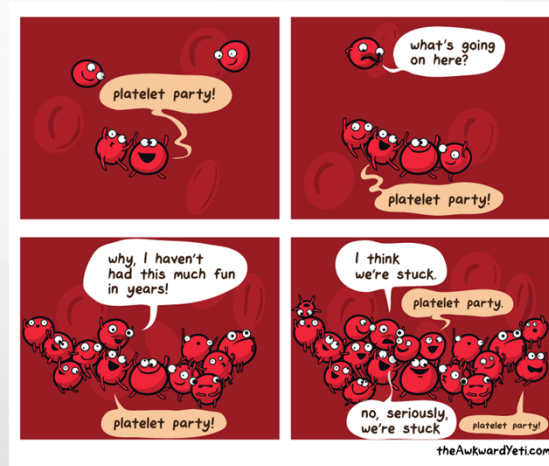
- BOTTOM LINE: ULTRASOUND ISN'T SUPERIOR TO OTHER IMAGING
  - BUT HAS ITS ROLE IN THE PATIENT IN EXTREMIS



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# TREATMENT



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# TREATMENT

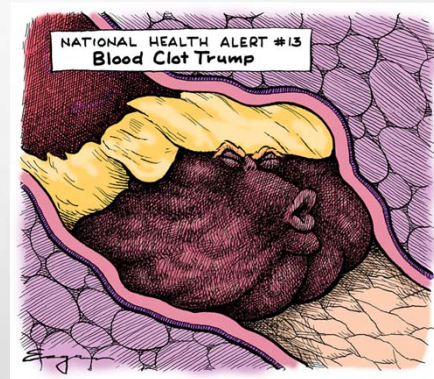
- **THREE TIERS OF PE**
  - **NON-MASSIVE**
  - **SUB-MASSIVE**
  - **MASSIVE**

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## TREATMENT – MASSIVE PE

I don't care how 'yuuuuuge' you are

- ANY PE WITH ASSOCIATED HYPOTENSION
  - SBP <90 MMHG FOR >15 MIN
  - DROP IN SBP OF >40
- NOT A RADIOGRAPHIC DIAGNOSIS



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## TREATMENT – MASSIVE PE

- THROMBOLYSIS
  - TPA PREFERRED AGENT
  - 100 MG OVER 2 HOURS
  - COUPLE WITH HEPARIN
- CATHETER DIRECTED THROMBOLYSIS
- EMBOLECTOMY



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## TREATMENT – SUBMASSIVE PE

- PE WITH SIGN OF:
  - RV DYSFUNCTION
    - DILATION ON IMAGING
    - BNP
    - ECG CHANGES
  - MYOCARDIAL NECROSIS



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## TREATMENT – SUBMASSIVE PE

- GOAL IS TO PREVENT PULMONARY HYPERTENSION AND RIGHT HEART FAILURE
- MOST STUDIES USED STANDARD DOSE TPA
  - 'MAPETT'/'TOPCOAT'/'PEITHIO'
  - MOST HAD SOME MORBIDITY BENEFIT
  - **VERY SLIGHT MORTALITY BENEFIT (1-2% ARR)**
  - INCREASED RISK OF ICH (5% ARI)



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## TREATMENT OF SUBMASSIVE PE

- HALF DOSE TPA
  - "TREND" TOWARDS DECREASED BLEEDING
  - NO STUDY HAS LOOKED AT LONG TERM OUTCOMES
  - SURROGATE MARKERS








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## TREATMENT – SUBMASSIVE PE

Courtesy Rebel EM

- BOTTOM LINE: CAN CONSIDER IN SOME PATIENTS WITH TENUOUS HEMODYNAMICS OR SEVERE SYMPTOM BURDEN WITH A LOW BLEEDING RISK

	Half Dose vs Full Dose	Half Dose vs No Dose
	No Diff	No Outcomes
	No Diff	No Diff
	Less Bleeding	No Diff
	Less ICH	No Diff
	No Diff	Less HD Decompensation

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## TREATMENT – NONMASSIVE PE

- EVERYONE ELSE
- REQUIRES ANTICOAGULATION

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## ANTICOAGULATION

- VERY FEW TRUE CONTRAINDICATIONS TO ANTICOAGULATION
  - IMMEDIATE POST OPERATIVE
  - ACTIVE BLEED
- SHOULD EVALUATE RISK OF BLEEDING WITH SCORING SYSTEM
  - HAS-BLED SCORE MOST COMMON
    - ANYTHING OVER 2 SHOULD PROMPT DISCUSSION OF RISKS AND BENEFITS
    - MORTALITY OF UNTREATED PE 5-25%

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# A BRIEF DISCUSSION ABOUT IVC FILTERS

# DON'T DO IT.

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# ANTICOAGULATION



VS



VS



VS



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# ANTICOAGULATION

- **LOW MOLECULAR WEIGHT HEPARIN**
  - FRAGMENTS OF HEPARIN-LIKE MOLECULES
  - GIVEN BY SUBCUTANEOUS INJECTION
- **COMMON DOSES**
  - ENOXAPAREN 1 MG/KG SC BID
  - ENOXAPAREN 1.5 MG/MG SC OD
  - DALTAPAREN 100 U/KG SC BID
  - DALTAPAREN 200 U//KG SC OD
  - TINZAPARIN 175 U/KG SC OD



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# ANTICOAGULATION

IF



OR



Then



\*Maybe not, we'll come back to that

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# ANTICOAGULATION

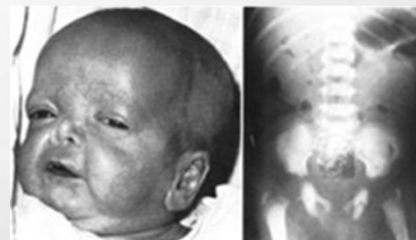
- DIRECT VITAMIN K ANTAGONIST

- WARFARIN
- TARGET INR 2-3
- NEED TO BRIDGE WITH LMWH/HEPARIN



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# ANTICOAGULATION



Fetal Warfarin Syndrome = infant with hypoplastic nose, flat face and low nasal bridge as well as altered calcification (Smith 1982).

Warfarin's Mortal Enemy

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# ANTICOAGULATION

- DIRECT ORAL ANTICOAGULANTS
  - DIRECT THROMBIN INHIBITORS
    - DABIGATRAN



...ish



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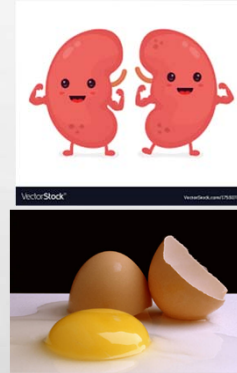
# ANTICOAGULATION



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# ANTICOAGULATION

- DIRECT ORAL ANTICOAGULANTS
  - FACTOR XA INHIBITORS
    - RIVAROXABAN
    - APIXABAN
    - EDOXABAN\*



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# ANTICOAGULATION

- UNFRACTIONATED HEPARIN
  - INTRAVENOUS BOLUS OF 80 U/KG
  - INFUSION OF 18 U/KG/HR
  - TARGET APTT 40-60
  - REQUIRE AN INFUSION



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# ANTICOAGULATION SUMMARY

- DOAC GENERALLY BEST
- WARFARIN IF REVERSAL IS IMPORTANT
- WARFARIN IF POOR KIDNEY FUNCTION
- LMWH IF YOU HAVE CANCER OR PREGNANT

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# DISCHARGE



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# WHO IS SAFE TO DISCHARGE HOME

- **HESTIA CRITERIA**
  - ALL NEGATIVE – 0% MORTALITY AT 30 DAYS
- **PESI CRITERIA (SIMPLIFIED)**
  - SCORE OF 0 HAS 0% MORTALITY AT 30 DAYS

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# WHO IS SAFE TO DISCHARGE HOME

The image displays three sequential screenshots of the Hestia Criteria mobile application. Each screen shows a question with 'No' and 'Yes' buttons. The final result is 0 points, indicating the patient is safe for outpatient treatment.

**Screen 1:**

- Question: Hemodynamically unstable (SBP <100 mmHg and HR >100, needing IV care, or by clinician judgment)
- Answer: No
- Question: Thrombolysis or endovascular needed (For reasons other than hemodynamic instability)
- Answer: No
- Question: Active bleeding or high risk for bleeding (If bleeding or category II stroke, skip this question. Skip bleeding disorder or platelet count <75% or abnormal PT/APTT <1.5x or aPTT <1.5x or by clinician judgment)
- Answer: No
- Result: 0 points Outpatient treatment

**Screen 2:**

- Question: <24 hrs on supplemental oxygen required to maintain SaO<sub>2</sub> >90%
- Answer: No
- Question: PE diagnosed while on anticoagulation
- Answer: No
- Question: Severe pain requiring IV pain medication required <24 hr
- Answer: No
- Question: Medical or social reason for admission <24 hr (Infection, malignancy, or support system)
- Answer: No
- Result: 0 points Outpatient treatment

**Screen 3:**

- Question: Creatinine clearance <30 mL/min by Cockcroft-Gault
- Answer: No
- Question: Severe liver impairment (By clinician judgment)
- Answer: No
- Question: Pregnant
- Answer: No
- Question: Documented history of heparin-induced thrombocytopenia (HIT)
- Answer: No
- Result: 0 points Outpatient treatment

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## WHO IS SAFE TO DISCHARGE HOME

The screenshot shows a mobile application interface for a 'Simplified PESI' calculator. The interface includes a header with a back arrow, the title 'Simplified PESI', and a star icon. Below the header are three tabs: 'CALCULATOR', 'RESULTS', and 'CREATE'. The 'CALCULATOR' tab is active, displaying several input fields with green selection buttons: 'Age' (set to '+60 years'), 'History of Cancer' (set to 'No'), 'History of chronic cardiopulmonary disease' (set to 'No'), 'Heart rate' (set to '+100 bpm'), 'Systolic BP' (set to '+100 mmHg'), and 'O<sub>2</sub> saturation' (set to '+90%'). At the bottom, a 'RESULT' section displays 'Low Risk' in bold green text.

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## DURATION OF ANTICOAGULATION

- **PROVOKED PE**
  - 3-6 MONTHS
  - IF PROVOCATIVE FACTOR REMOVED
- **UNPROVOKED**
  - AT LEAST THREE MONTHS
  - STRONG CONSIDERATION FOR LIFETIME



vs



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## RISK OF RECURRENCE

- **PROVOKED VTE**
  - 1-5% RECURRENCE RATE OVER 5 YEARS
- **UNPROVOKED VTE**
  - 10% RISK IN THE FIRST YEAR
  - 30% RISK IN THE FIRST FIVE YEARS
    - THIS IS SUB-BUENO
- **MALE VS FEMALE**



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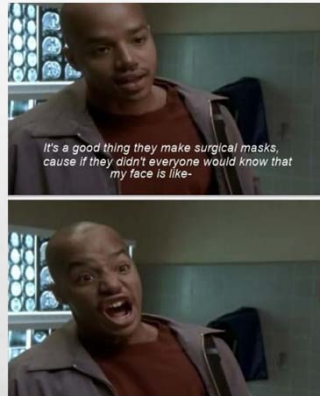
## RISK OF RECURRENCE

- **CALCULATORS FOR RISK RECURRENCE**
  - HERD002
  - DASH



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## PREGNANCY AND PE



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## PREGNANCY AND PE

- HIGHEST RISK TIME?
  - RELATIVE RISK
- RISK FACTORS
- VITAL SIGNS
- D-DIMER
- WHO TO EVALUATE?

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# PREGNANCY AND PE

- PE EVALUATION?
  - CTPE
    - WORSE FOR MOM
    - BETTER FOR FETUS
  - V/Q SCAN
    - BETTER FOR MOM
    - WORSE FOR FETUS
  - ACCURACY?



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# PREGNANCY AND PE

**Table 2. Effects of Gestational Age and Radiation Dose on Radiation-Induced Teratogenesis**

Gestational Period	Effects	Estimated Threshold Dose*
Before implantation (0-2 weeks after fertilization)	Death of embryo or congenital anomalies (all or none)	50-100 mGy
Organogenesis (2-8 weeks after fertilization)	Congenital anomalies (limbs, heart, skeleton, eyes, genitalia)	200 mGy
	Growth restriction	200-250 mGy
Fetal period		Estimated Threshold Dose*
8-15 weeks	Severe intellectual disability (high risk) <sup>†</sup>	60-310 mGy
	Intellectual disability (low risk)	25 IQ-point loss per 1,000 mGy
	Microcephaly	200 mGy
16-25 weeks	Severe intellectual disability (low risk)	250-280 mGy*

\*Data based on results of animal studies, epidemiologic studies of the atomic bombings in Japan, and studies of groups exposed to radiation for medical reasons (eg, radiation therapy for cancer of the head and neck, and radioiodine therapy for hyperthyroidism).  
<sup>†</sup>Because this is a period of rapid neuronal development and migration, the risk of severe intellectual disability is higher.  
 Modified from Patel SJ, Reede DL, Katz DS, Subramaniam R, Anonson J. Radiation exposure in the pregnant patient for nonobstetric conditions: algorithms and radiation dose considerations. *Radiographics* 2007;27:1702-1710.

**Table 3. Fetal Radiation Doses Associated With Common Radiologic Examinations**

Type of Examination	Fetal Dose* (mGy)
<i>Very low-dose examinations (&lt;0.1 mGy)</i>	
Cervical spine radiography (anteroposterior and lateral views)	<0.001
Head or neck CT	0.001-0.01
Radiography of any extremity	<0.001
Mammography	<0.001
<i>Low-dose examinations (0.1-10 mGy)</i>	
Chest radiography (two views)	0.0005-0.01
Abdominal radiography	0.1-3.0
Lumbar spine radiography	1.0-10
Intravenous pyelography	5-10
Double-contrast barium enema	1.0-20
<i>Higher-dose examinations (10-50 mGy)</i>	
Chest CT or CT pulmonary angiography	0.01-0.66
Low-dose perfusion scintigraphy	0.1-0.5
Pulmonary digital subtraction angiography	0.5
<i>High-dose examinations (10-50 mGy)</i>	
Abdominal CT	1.3-35
Pelvic CT	10-50
<sup>18</sup> F PET/CT whole-body scintigraphy	10-50

Abbreviations: CT, computed tomography; PET, positron emission tomography.  
 \*Fetal exposure varies with gestational age, maternal body habitus, and exact acquisition parameters.  
 Note: Annual average background radiation = 1.1-2.5 mGy. <sup>18</sup>F = 2-[thorium-188]fluoro-2-deoxy-D-glucose.  
 Modified from Tremblay E, Therasse E, Thomassin-Naggara I, Trop I. Quality initiatives: guidelines for use of medical imaging during pregnancy and lactation. *Radiographics* 2012;32:897-911.

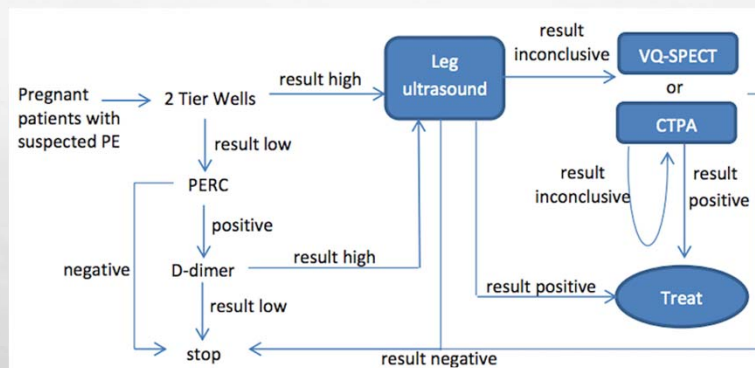
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## PREGNANCY AND PE

- **D-DIMER DIFFICULT TO USE**
  - MULTIPLE STUDIES SHOWING LOW SPECIFICITY
  - STILL SENSITIVE
  - ONGOING DEVELOPMENT OF 'TRIMESTER ADJUSTED D-DIMER'

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## PREGNANCY AND PE



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## ANTICOAGULATION IN CANCER

- TYPICAL THERAPY IS LMWH
- DOACS HADN'T BEEN STUDIED
- *UNTIL NOW*



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## ANTICOAGULATION IN CANCER

- RASKOB (2018)
  - OPEN LABEL, NON-INFERIORITY TRIAL
  - PATIENT'S HAD CANCER WITHIN LAST 2 YEARS
  - 5 DAYS OF LMWH THEN EDOXABAN 60 MG DAILY VS DAILY LMWH
  - LOOKED AT RISK OF RECURRENT VTE AND BLEEDING RISK

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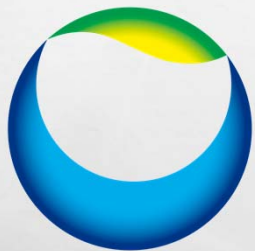
# ANTICOAGULATION IN CANCER

- **RESULTS**

- **BLENDED ENDPOINT : 12.8 IN EDOXABAN VS 13.5% IN LMWH**
  - NON-INFERIOR AS PER STUDY DESIGN
- **RECURRENT VTE: 7.9% VS 11.3% (NONSIGNIFICANT)**
- **MAJOR BLEEDING: 6.9% VS 4.0% (SIGNIFICANT)**
  - ALMOST ALL BLEEDING IN GI CANCERS
- **6 MONTH ANALYSIS**
  - HIGHER BLEEDING RATE

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# ANTICOAGULATION IN CANCER



Daiichi-Sankyo

A pharmaceutical company,  
meddling in a research study to  
make its own drug look good?  
Well I never!

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## ADVANCES IN PE RESEARCH

Old D-Dimer Threshold



New D-Dimer Threshold

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## THE YEARS CRITERIA

- **VAN DER HULLE (2017)**
  - MULTICENTRE PROSPECTIVE COHORT STUDY
  - USED THREE CRITERIA RULE
    - HEMOPTYSIS
    - CLINICAL SIGNS OF DVT
    - PE MOST LIKELY DIAGNOSIS
  - IF ALL NEGATIVE – D-DIMER <1000
  - IF ANY POSITIVE – D-DIMER <500
  - IMAGING IF “POSITIVE” D-DIMER
  - FOLLOWED FOR 3 MONTHS

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# THE YEARS CRITERIA

- **RESULTS**
  - 14% ABSOLUTE REDUCTION IN ADVANCED IMAGING ORDERED FOR PE
  - CONSISTENT ACROSS ALL SUBGROUPS
  - 19 "NEGATIVE" PATIENTS WERE FALSE NEGATIVES (0.61%)
- **FLAWS**
  - HIGH PREVALENCE OF PE (13%)
  - INVESTIGATORS KNEW D-DIMER RESULT BEFORE THEY APPLIED THE YEARS CRITERIA

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# THE YEARS CRITERIA

- **KABRHEL (2018)**
  - MULTICENTRE OBSERVATION STUDY
  - DATA COLLECTED BUT CLINICAL PRACTICE UNCHANGED
  - WOULD LEAD TO A 21% REDUCTION IN IMAGING
  - 6 PATIENTS (0.3%) HAD MISSED PE

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## SUBSEGMENTAL PE

- ISOLATED CLOT IN ARTERY DISTAL TO ONE OF THE MAIN BRANCHES OF PULMONARY ARTERIES
- ?NORMAL FUNCTION OF LUNGS
- DO THESE PATIENTS NEED ANTICOAGULATION?



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## SUBSEGMENTAL PE

- CHEST GUIDELINES (2016)
  - NO ANTICOAGULATION IF:
    - ISOLATED SUBSEGMENTAL PE
    - NO PROXIMAL DVT
    - LOW RISK OF RECURRENCE/COMPLICATIONS
- ACEP GUIDELINES (2018)
  - "GIVEN THE LACK OF EVIDENCE, ANTICOAGULATION TREATMENT DECISIONS FOR PATIENTS WITH SUBSEGMENTAL PE WITHOUT ASSOCIATED DVT SHOULD BE GUIDED BY INDIVIDUAL PATIENT RISK PROFILES AND PREFERENCES."

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## SUBSEGMENTAL PE

- **BOTTOM LINE: IN LOW RISK PATIENTS, OR HIGH RISK BLEEDING, ISOLATED SUBSEGMENTAL PE MAY NOT NEED ANTICOAGULATION**

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## ANY QUESTIONS?



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