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# VASCULAR THERAPIES

# 2024

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2024

# Pulmonary Embolism Management: How Important is a PERT?

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# Disclosures

- None

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# Outline

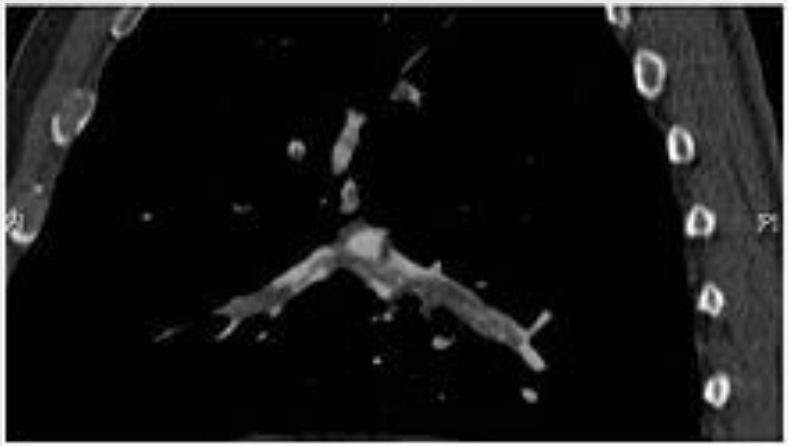
- What is PERT?
- Origins, Purpose, Operation, and Structure
- Function and Approach
- Goals
- Quality Assurance Database
- Long-term Follow-up

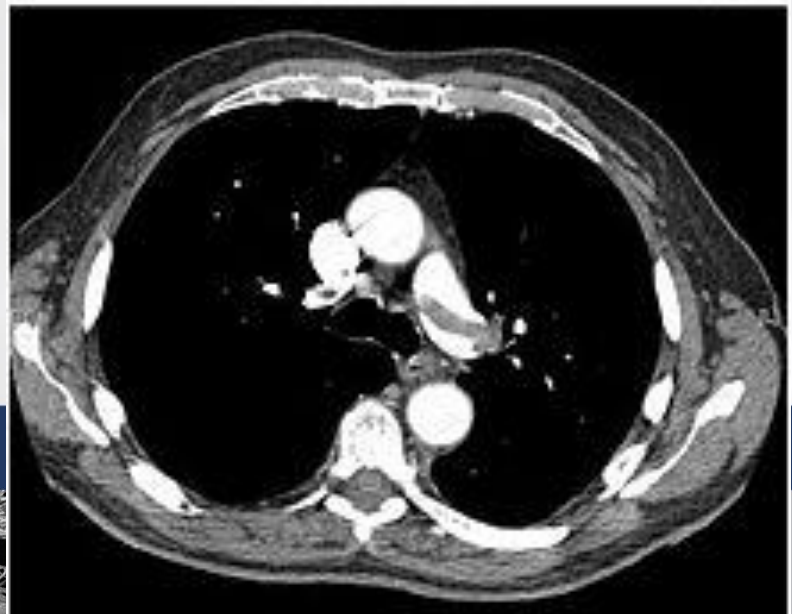
# WWYD?

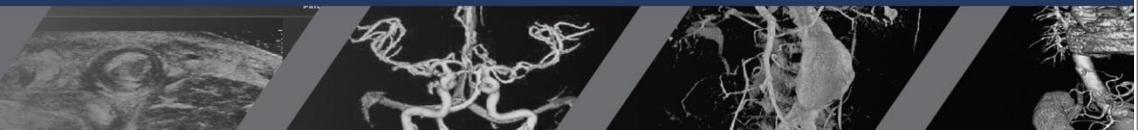
- 45 year old female comes to the ER with chest pain and shortness of breath.
- She has had a prior DVT for which she received coumadin for a year.
- She stopped her blood thinner 3 months ago.
- Elective ankle surgery 2 weeks ago.
- HR 115
- BP 90/60
- O2 sat 94% on Non Re-breather

# WWYD?

- Echo shows dilated right ventricle
- BNP 1200
- Troponin 1.2

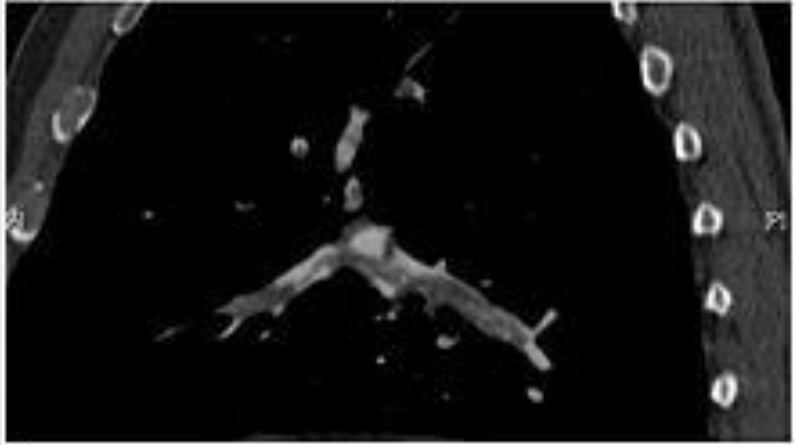


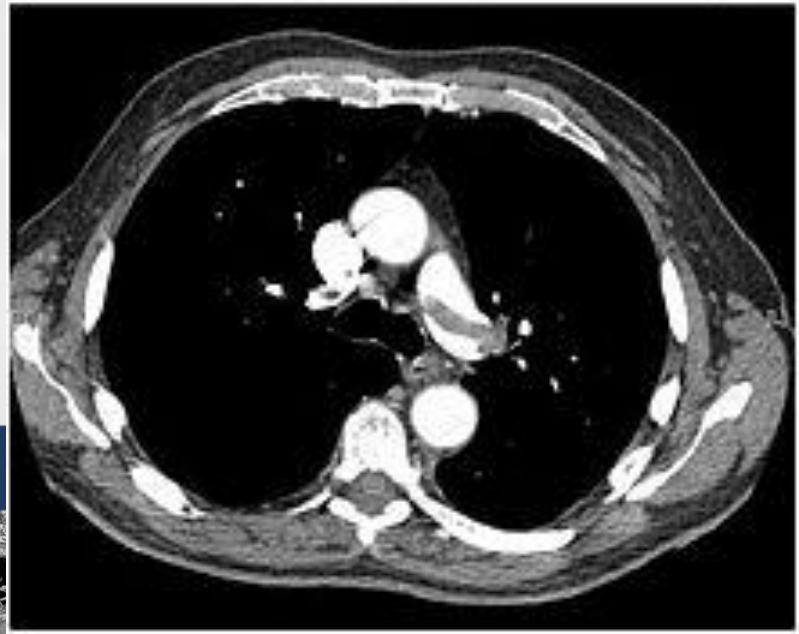


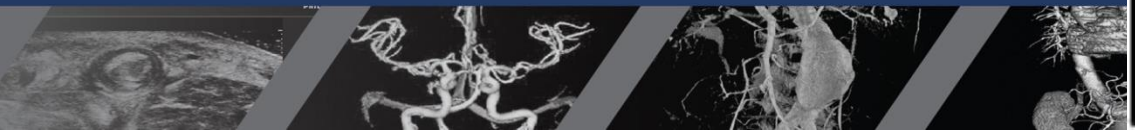


# WWYD?

- What now?
- Who makes the decision?
- How do they make the decision?
- Will the best treatment plan be offered to this patient?







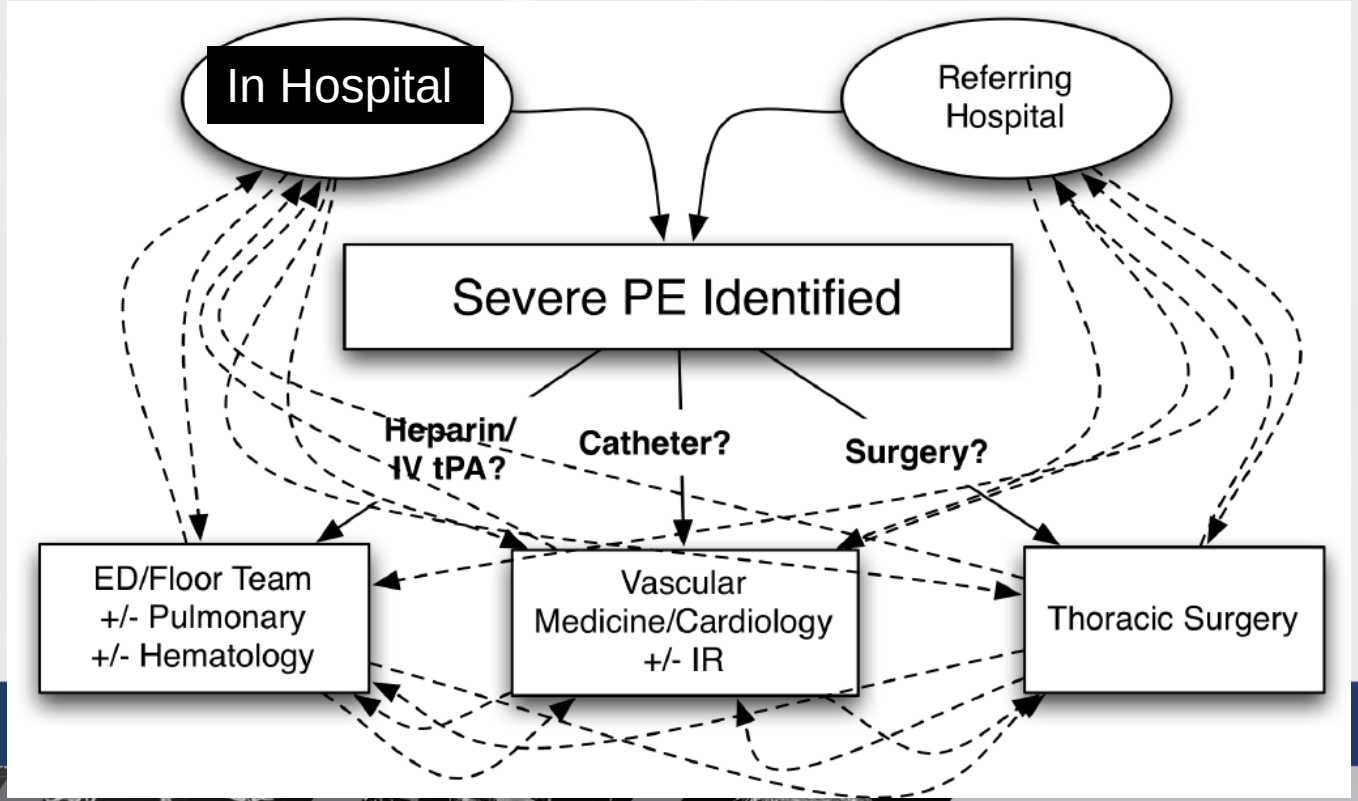
# Treatment?

- Admitted to hospitalist
  - Pulmonary Critical Care Consult
    - Consider systemic TPA
      - 2/3 of TPA withheld in appropriate patients due to concerns of bleeding risk
    - Therapeutic anticoagulation
  - CT Surgery Consult
    - Is there a role for embolectomy?
  - Vascular Surgery Consult
    - Is there a role for catheter directed TPA? Thrombectomy?
    - What is the source of the VTE

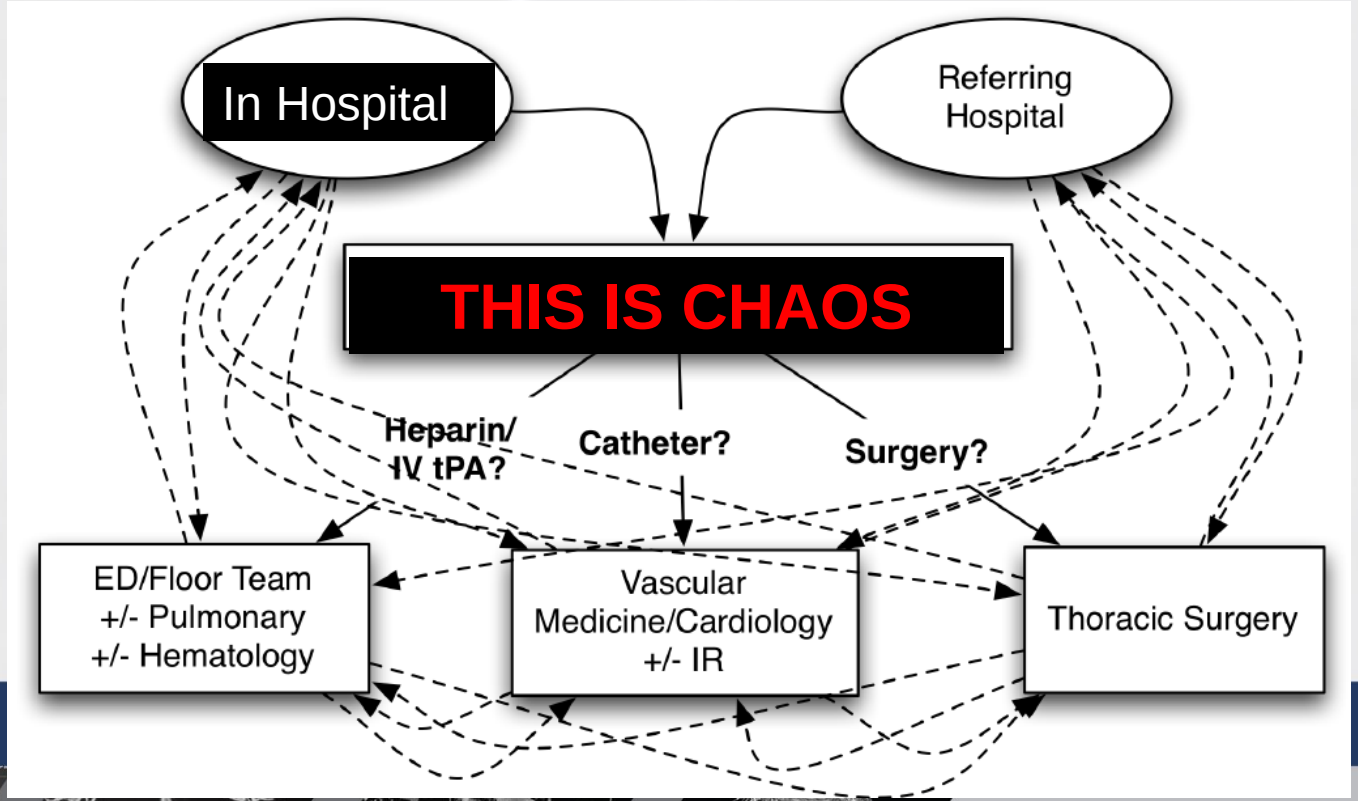
# Treatment?

- 6 notes in the computer
- No centralized discussion amongst doctors to determine the best treatment for this patient
- Is this the optimal solution for our patient?

# Other Systems



# Other Systems



# Origins and Purpose

- USA: 100,000 PE deaths yearly
  - Third most common cause of Cardiovascular Death
- Variability in treatment strategies particularly in submassive or massive PE.
  - Paucity of robust clinical trials.
  - Varied clinical guidelines
  - 1. European Society of Cardiology (ESC), [8]
  - 2. American Heart Association, [9]
  - 3. American College of Chest Physicians. [10]

# Origins and Purpose

- To develop more effective and streamlined treatment strategies for PE
- Using lessons from:
  - 1. The multidisciplinary approach that is central to the working of tumor boards [11]
  - 2. STEMI or *Heart Team* in cardiology [12]
  - 3. Rapid Response [13] - prompt and focused delivery of critical care services

# What is PERT?

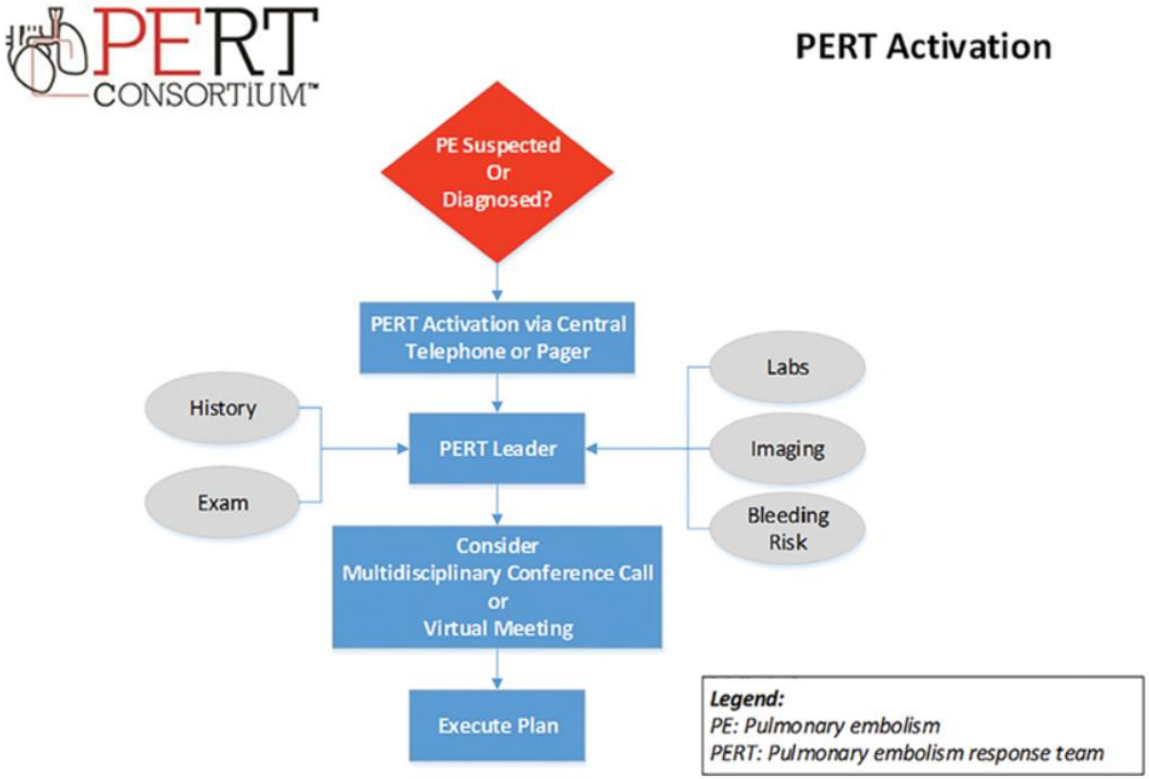
- The Pulmonary Embolism Response Team (PERT) is an institutionally-based multidisciplinary team

1. Rapidly assess and provide treatment for patients with acute pulmonary embolism (PE).
2. Formal mechanism to execute a full range of medical, endovascular, and surgical therapies.
3. Provides appropriate multidisciplinary follow-up of patients.

# Origins and Purpose

- 2012, Dr. Kenneth Rosenfield at Massachusetts General Hospital (MGH) created the pulmonary embolism response team (PERT).
  - Physicians across a range of relevant medical specialties who could meet expeditiously as a group and individualize a thoughtful, coordinated, and comprehensive treatment plan for PE patients.
- Currently there are > 100 institutions in the United States with PERTs.
- **PERT Consortium** established in 2015 in Boston
  - Members from over 40 institutions with established or planned PERT
  - This body was created to advance the diagnosis, treatment, and **outcomes** of patients with PE throughout the world.

# Operation and Structure




Scheme for the activation of the pulmonary embolism response team. (Used with permission from Rivera-Lebron B, McDaniel M, Ahrar K, et al. Diagnosis, treatment and follow up of acute pulmonary embolism: consensus practice from the PERT consortium. Clin Appl Thromb Hemost 2019;25:1076029619853037.)

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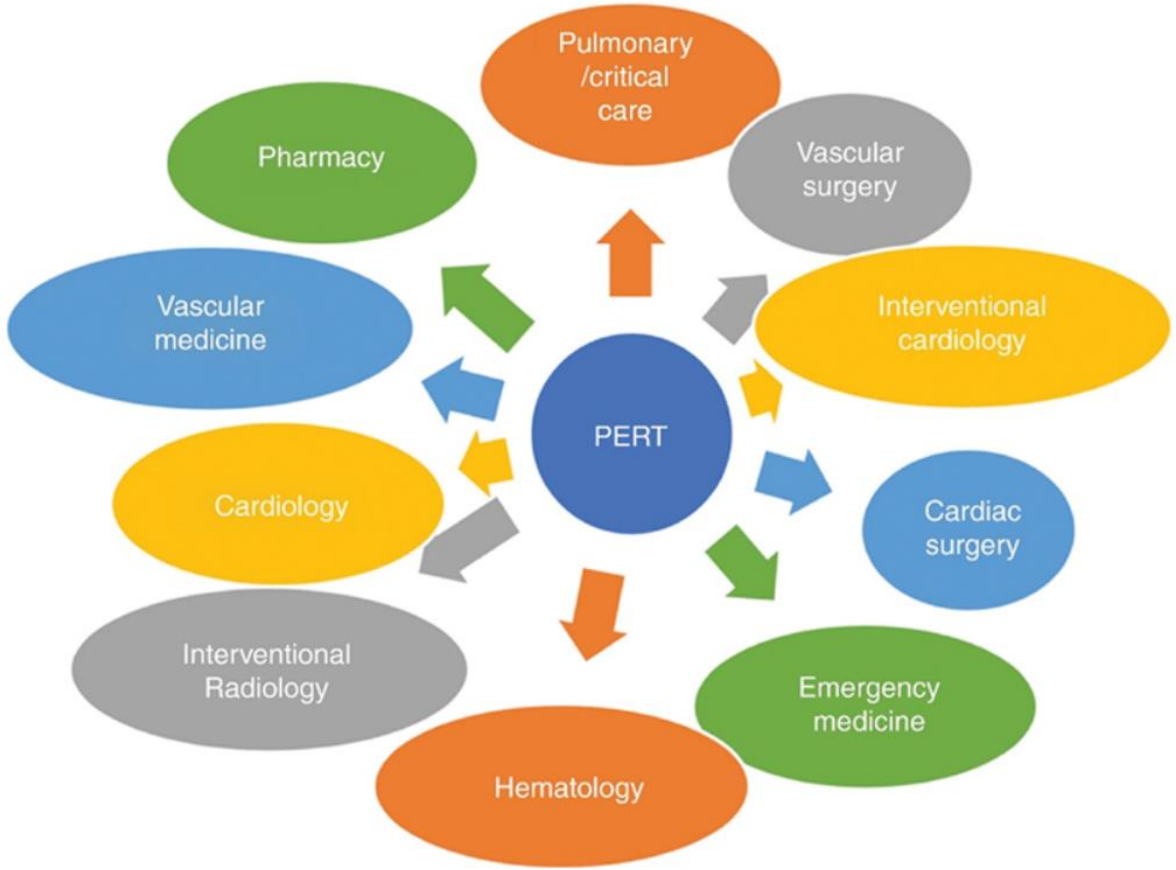
Fig. 2




Range of subspecialities that may be part of the pulmonary embolism response team. (Used with permission from Rosovsky R, Zhao K, Sista A, Rivera-Lebron B, Kabrhel C. Pulmonary embolism response teams: purpose, evidence for efficacy, and future research directions. Res Pract Thromb Haemost 2019;3:315–330.)

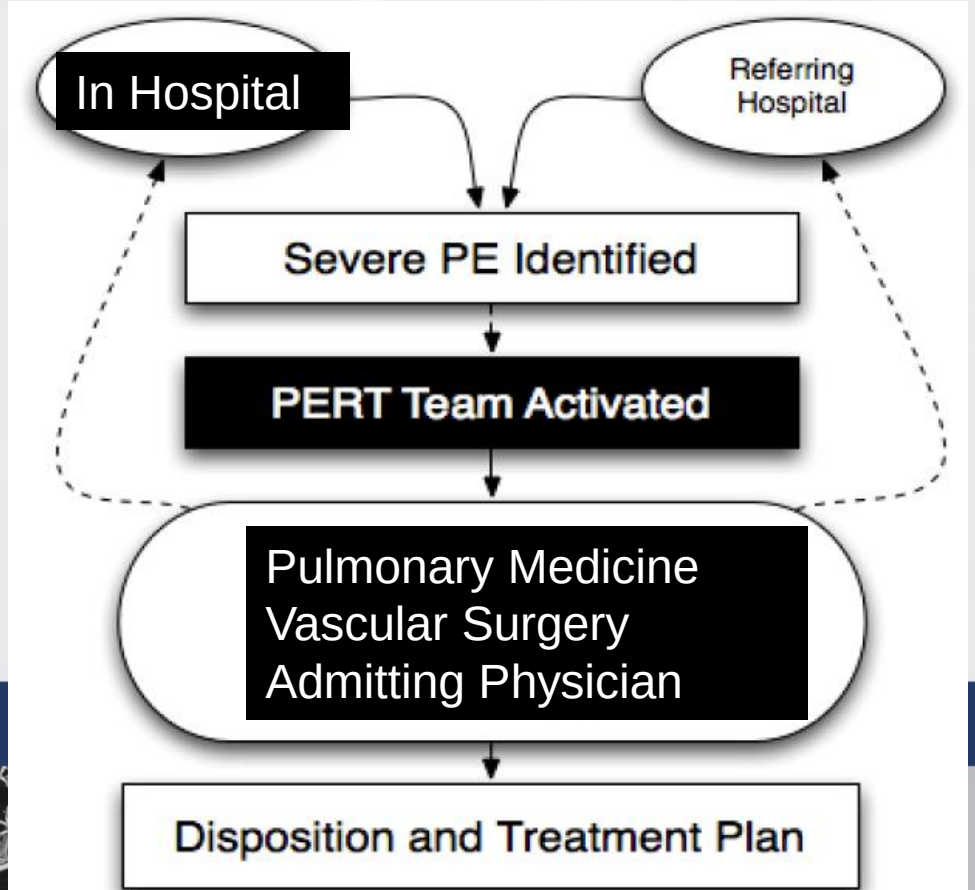
"Institutionally-based"
Composition depends on:

- Resources
- Expertise
- Experience
- Availability of personnel
- Local practice patterns

# The PERT Follow-Up Clinic

- PE recurrence risk 8% at 6 mos
  - Monitor for continued resolution of PE symptoms
  - Investigate new symptoms suggestive of VTE
- CTEPH – Chronic Thromboembolic Pulmonary Hypertension
  - May affect up to 5% of PE patients
  - Persistent/progressive dyspnea esp 3mos – 2 year
  - Low threshold to repeat CTA/VQ if VTE/CTEPH suspected
- If UNPROVOKED VTE: search for underlying cause
  - Malignancy
  - Inherited coagulation disorder

# PE Response Team (PERT) at Sentara




# 73 year old man with chest pain and shortness of breath

- Admission testing included:
  - CBC/BMP
  - CT scan
  - Pro BNP
  - Troponin
  - PT/INR
  - Echo

# Results

- Echo demonstrated large RV
  - Paradoxical motion of septum
  - Estimated PA pressures of 55
- Pro BNP 526
- CTA Chest:


R
L
20CM
20CM

## APPENDIX A: Classifications of Pulmonary Embolism (PE)

| Risk Levels | Classifications |
|---|---|
| **Low Risk** | • No hypotension **and**<br>• No RV dysfunction **and**<br>• No myocardial necrosis or strain |
| **Low-Intermediate Risk** | • RV dysfunction by CT or ECHO **or**<br>• Myocardial necrosis or strain (elevated Troponin T or NT-proBNP) |
| **High-Intermediate Risk** | • RV dysfunction by CT or ECHO **and**<br>• Myocardial necrosis or strain (elevated Troponin T or NT-proBNP) **and/or**<br>• Absence of signs of hypotension or shock |
| **High Risk** | • Sustained hypotension (SBP less than 90 mmHg) at least 15 minutes **or**<br>• Persistent bradycardia (HR less than 40 bpm) or signs and symptoms of shock **or**<br>• Need for inotropic support |

RV = right ventricular
SBP = systolic blood pressure
HR = heart rate

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# PERT in action

## INITIAL EVALUATION – INTERMEDIATE RISK[1]

PERT First Responder[2] contacted for patient **with Pulmonary Embolism (PE) and Intermediate Risk**[1]
- Notify Primary Team (if not already aware of PE)
- For Pediatric considerations, see Appendix B

Obtain the following (if not already done):
- NT-proBNP, troponin T, type and screen
- Routine 2D-ECHO[3]
- EKG 12-Lead (portable)
- Ultrasound of leg or venous doppler bilaterally as clinically indicated

Absolute contraindication[4] to anticoagulation?

Yes → A → Risk stratification assessed by PESI score[5]

No → See Page 3

RR = respiratory rate
HR = heart rate
SBP = systolic blood pressure
AMS= altered mental status

[1] See Appendix A: Classifications of Pulmonary Embolism
[2] PERT First Responder: On-Call fellow/trainee and attending provider
[3] See Appendix C: Criteria for After Hours STAT 2D-ECHO
[4] See Appendix D: Contraindications to Anticoagulation Therapy
[5] PESI score calculators:
https://www.mdcalc.com/pulmonary-embolism-severity-index-pesi or
https://www.mdapp.co/pulmonary-embolism-severity-index-pesi-score-calculator-118

## INITIAL EVALUATION – INTERMEDIATE RISK[1]

No absolute contraindication[2] to anticoagulation

RR ≥ 30 breaths/minute **or** $O_2$ saturation on room air < 90% **or** HR ≥ 110 beats/minute **or** SBP <100 mmHg **or** AMS

Yes → Start IV unfractionated heparin[3,4,5] → Risk stratification assessed by PESI score[6]

No → Start LMWH[5,8]

Risk stratification assessed by PESI score[6] → High-Intermediate[1] Risk PE and PESI score ≥ 86

Risk stratification assessed by PESI score[6] → High-Intermediate[1] Risk PE and PESI score < 86 **or** Low-Intermediate[1] Risk PE

RR = respiratory rate
HR = heart rate
SBP = systolic blood pressure
AMS= altered mental status

[1] See Appendix A: Classifications of Pulmonary Embolism
[2] See Appendix D: Contraindications to Anticoagulation Therapy
[3] Refer to Adult Heparin Infusion order set
[4] If patient has a history of heparin induced thrombocytopenia (HIT), see Heparin Induced Thrombocytopenia (HIT) Treatment algorithm for mana
[5] May consider Low Intensity dosing of IV unfractionated heparin for patients with relative contraindication to anticoagulationtherapy (see Apper contraindication to anticoagulation.
[6] PESI score calculators:
https://www.mdcalc.com/pulmonary-embolism-severity-index-pesi or
https://www.mdapp.co/pulmonary-embolism-severity-index-pesi-score-calculator-118
[7] Refer to GCC home page (for internal use only)
[8] See Appendix E: Low Molecular Weight Heparin (LMWH) Regimens for Treatment of Cancer Associated Thrombosis

# BOVA

**Formula**

Addition of the selected points:

| | 0 points | 1 point | 2 points |
|---|---|---|---|
| Systolic BP | >100 mm Hg | -- | 90-100 mmHg |
| Elevated cardiac troponin* | No | -- | Yes |
| RV dysfunction** | No | -- | Yes |
| Heart rate, beats/min | <110 | ≥110 | -- |

*Based on standard manufacturer assays and cutoff values.

**On TTE: Right to left ventricular (RV/LV) ratio >0.9, systolic pulmonary artery pressure (sPAP) >30, RV end diastolic diameter >30mm, RV dilation, or free wall hypokinesis. On CT: RV/LV ratio >1 based on short axis diameter measurements.

**Facts & Figures**

Interpretation:

| BOVA Score | Stage | PE-related complications* | PE-related mortality |
|---|---|---|---|
| 0–2 | I (Low risk) | 4.4% | 3.1% |
| 3–4 | II (Intermediate risk) | 18% | 6.8% |
| >4 | III (High risk) | 42% | 10% |

*Defined as a composite including death from PE, hemodynamic collapse, or recurrent nonfatal PE. Hemodynamic collapse = systolic BP <90 mm Hg for at least 15 min or need for catecholamines, thrombolysis, endotracheal intubation, or CPR.

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# PESI

- Pulmonary Embolism Severity Index

| PESI variable | Points awarded |
|---|---|
| 1. Age of the patient | 1 per year |
| 2. Gender | Male (20)<br>Female (0) |
| 3. Temperature <36°C / 96.8°F | 20 |
| 4. Systolic blood pressure <100 mmHg | 30 |
| 5. Heart rate >110 bpm | 20 |
| 6. Respiratory rate >30 breaths per minute | 20 |
| 7. Arterial oxygen saturation below 90% | 20 |
| 8. History of chronic lung disease | 10 |
| 9. History of heart failure | 10 |
| 10. Alteration of mental status | 60 |
| 11. Malignancy | 30 |

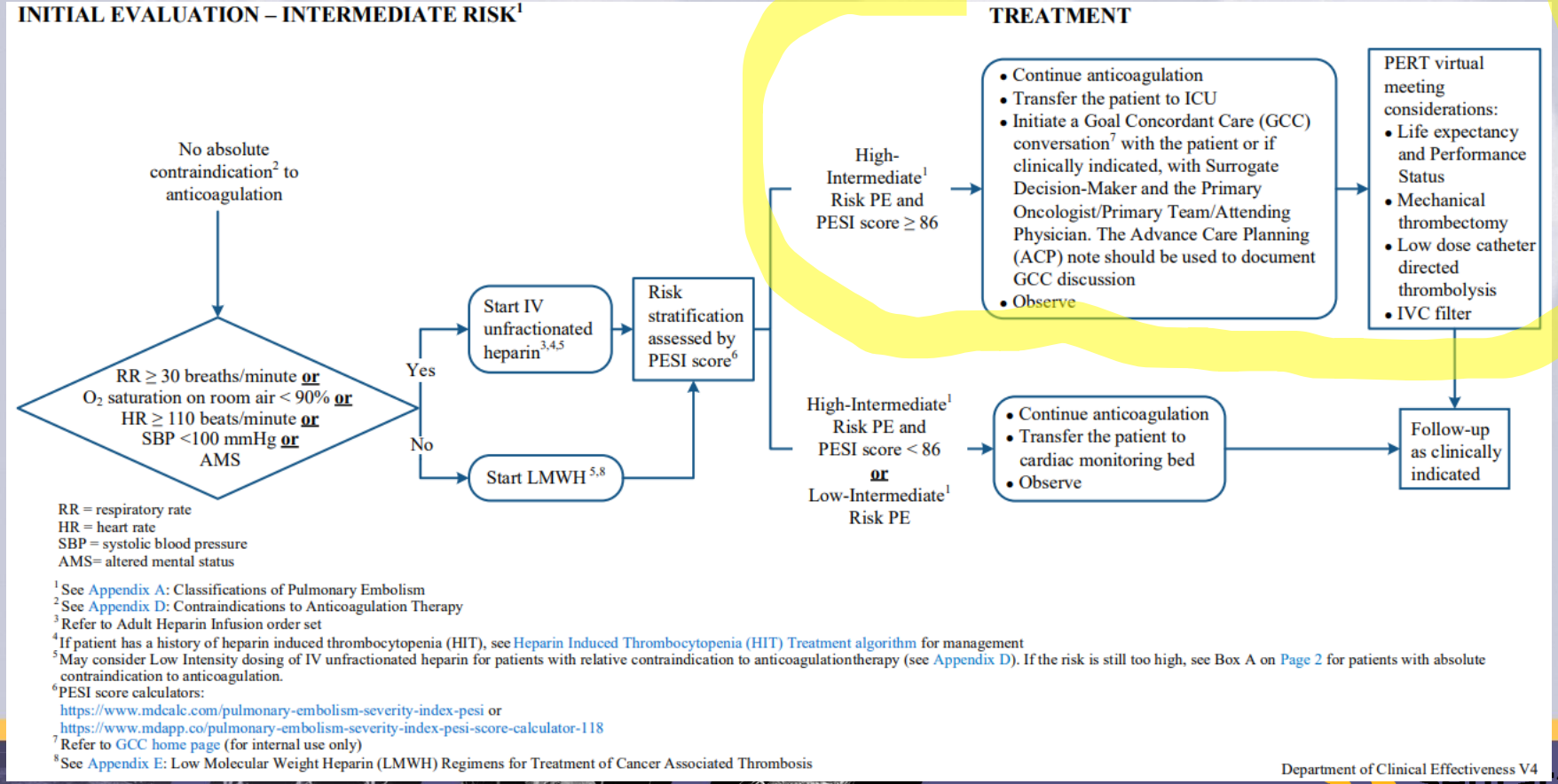
**Result interpretation**

The prognosis classification in five severity classes and their associated 30-day mortality risk and probability, can be found in the table below:

| PESI Score | Class | Mortality Risk | Probability (30d) |
|---|---|---|---|
| 0 - 65 | I | Very low | up to 1.6% |
| 66 - 85 | II | Low | 1.7 - 3.5% |
| 86 - 105 | III | Moderate | 3.2 - 7.1% |
| 106 - 125 | IV | High | 4 - 11.4% |
| >126 | V | Very high | 10 - 24.5% |

Low risk classes, I and II may be considered for outpatient treatment. High risk cases however, classes III, IV and V require higher levels of care, usually in the ICU.

# PERT in action

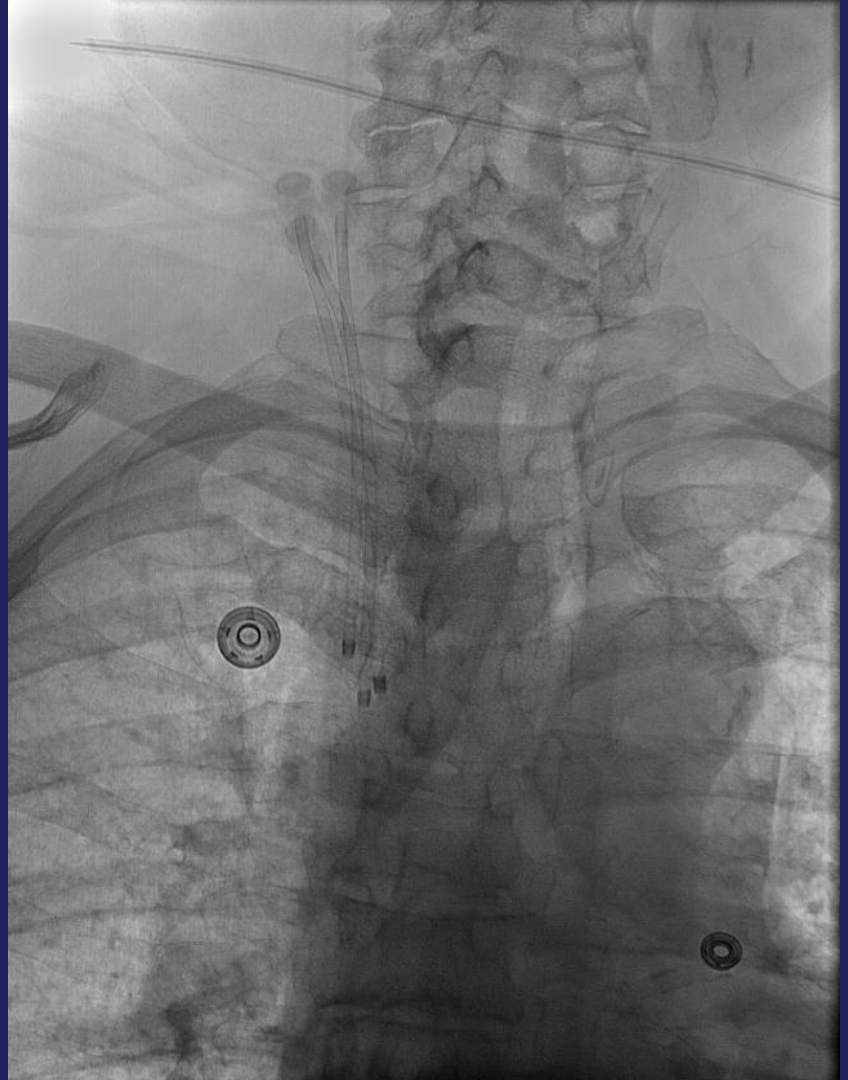


# Multidisciplinary Discussion

- Risks and benefits of TPA at 73 years old
- Thrombus burden and classification of his PE
  - 100 mg TPA systemic
  - 50 mg TPA systemic
  - Low dose catheter directed TPA or percutaneous thrombectomy
  - Open embolectomy
  - Systemic anticoagulation and supportive care

# How was this case handled

- Pt was started on therapeutic heparin
- Catheter directed therapy to the bilateral PE
  - Low Dose TPA given his age of >70.
- LE Duplex and IVC duplex showed a L femoral and iliac DVT
  - No symptoms so no surgical therapy



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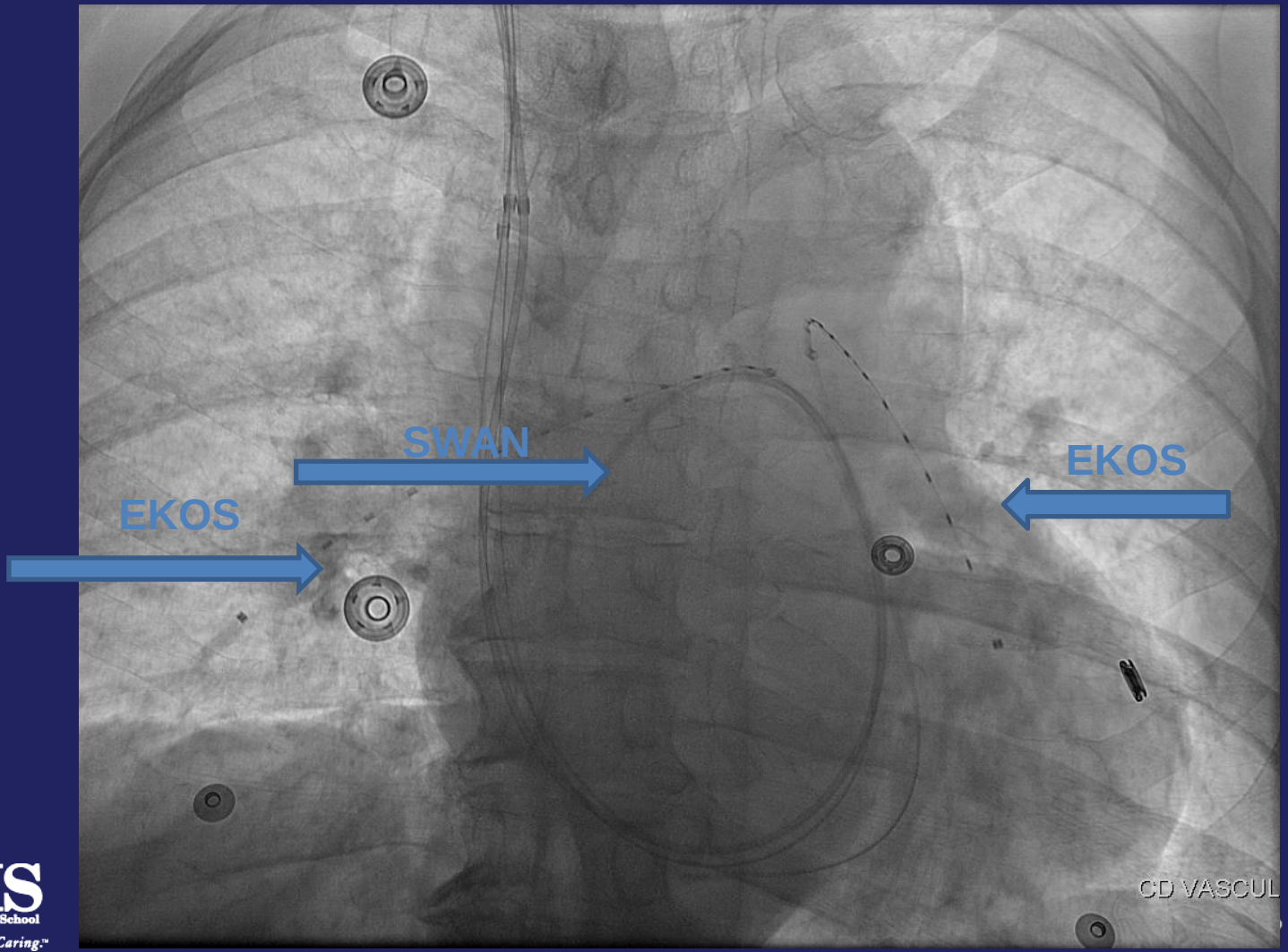


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# POD #1

- TPA administered at 1mg/hr/catheter
- Low dose heparin in each sheath
- Swan PA pressures monitored until resolution of PA hypertension
- Fibrinogen, PTT, CBC  and hemodynamics monitored for signs/symptoms of bleeding

# Post Op Care

- Discharge planning
  - Plan for 12 months of anticoagulation
  - Compression stockings 30-40mmHg for two years
  - 72 hour echo to look for resolution of right heart strain
  - 3 month follow up appt. to assess for resolution of right heart strain and symptoms of post thrombotic syndrome (CTEPH)

# So How Do We Get There?

- Step one
  - Prompt Identification of Disease
- Step two
  - Risk Stratification
- Step three
  - Develop a Patient and Disease Specific Plan

# Outcomes Following Introduction a PERT Program

- Mission of Consortium: advance the diagnosis, treatment, and **outcomes** of patients with PE throughout the world.
- Large, prospective database is currently being collected
- Analysis of database --> Quality assurance
- Does PERT result in improved PE management?
- Does PERT result in improved clinical outcomes?

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Am J Cardiol. 2019 Nov 1;124(9):1465-1469. doi: 10.1016/j.amjcard.2019.07.043. Epub 2019 Aug 7.

## Impact of Multidisciplinary Pulmonary Embolism Response Team Availability on Management and Outcomes

Pulkit Chaudhury [1], Shruti Kumar Gadre [2], Erika Schneider [3], Rahul D Renapurkar [3], Marcelo Gomes [4], Ihab Haddadin [3], Gustavo A Heresi [2], Michael Z Tong [5], John R Bartholomew [4]

Affiliations + expand

PMID: 31495443 DOI: 10.1016/j.amjcard.2019.07.043

### Abstract

Treatment strategies for complex patients with pulmonary embolism (PE) are often debated given patient heterogeneity, multitude of available treatment modalities, and lack of consensus guidelines. Although multidisciplinary Pulmonary Embolism Response Teams (PERT) are emerging to address this lack of consensus, their impact on patient outcomes is not entirely clear. This analysis was conducted to compare outcomes of all patients with PE before and after PERT availability. We analyzed all adult patients admitted with acute PE diagnosed on computed tomography scans in the 18 months before and after the institution of PERT at a large tertiary care hospital. Among 769 consecutive inpatients with PE, PERT era patients had lower rates of major or clinically relevant nonmajor bleeding (17.0% vs 8.3%, p = 0.002), shorter time-to-therapeutic anticoagulation (16.3 hour vs 12.6 hour, p = 0.009) and decreased use of inferior vena cava filters (22.2% vs 16.4%, p = 0.004). There was an increase in the use of thrombolytics/catheter-based strategies, however, this did not achieve statistical significance (p = 0.07). There was a significant decrease in 30-day/inpatient mortality (8.5% vs 4.7%, p = 0.03). These differences in outcomes were more pronounced in intermediate and high-risk patients (mortality 10.0% vs 5.3%, p = 0.02). The availability of multidisciplinary PERT was associated with improved outcomes including 30-day mortality. Patients with higher severity of PE seemed to derive most benefit from PERT availability.

# Chaudhury et al at Cleveland Clinic

- Retrospective cohort analysis 2019
- 18 mos pre and post PERT
- 700: 300/400 patients
- PERT era:
- Shorter time to thx anticoag: 12.6 vs. 16.3 hours
- Less major bleeding: 8.3 vs. 17%
- Fewer IVCF: 16.1 vs. 24.6%)
- Lower 30-day mortality: 10 vs. 5.3%

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# *RESPONSE:* Do Pulmonary Embolism Response Teams Result in Improved Outcomes in Patients With Pulmonary Embolism?

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Drs. Brailovsky and Lakhter have written a cogent and erudite piece on the benefits, drawbacks, and future directions of the concept of a pulmonary embolism response team (PERT), especially as it pertains to the involvement of fellows as part of this team. As they have stated, pulmonary embolism (PE) is the third leading cause of cardiovascular death; yet, there is no standard approach to treatment of this condition in the intermediate high-risk PE patient.

One of the goals of a PERT is to reduce the variation in treatment for acute PE resulting in improved care when experts in pulmonary/critical care medicine, cardiology, vascular medicine, hematology, emergency medicine, interventional radiology, and cardiovascular surgery work together to manage complicated critically ill patients with PE. Each institution will have a slightly different team makeup of specialists involved based on the expertise at any given center. Additionally, the method of team activation and the intricacies of decision-making will vary among institutions, because there

Although the standardization of care may result from having a PERT in an institution, it is still not clear if activation of a pulmonary embolism response team results in improved outcomes. The study by Chaudhury et al. (2) nicely illustrates this point. They retrospectively analyzed intermediate- to high-risk patients in the pre-PERT era (n = 289) and PERT era (n = 378). In the PERT era, the time to therapeutic anticoagulation was shorter, the use of IVC filters was less common (24.6% vs. 16.1%; p = 0.008), major and clinically relevant nonmajor bleeding was less (19.2% vs. 8.6%; p < 0.001), and 30-day mortality was lower (10% vs. 5.3%; p = 0.020) compared with the pre-PERT era. These outcome improvements occurred despite the fact that the pulmonary embolism response team was activated and managed the care of the patient in only 57 (15%) of the 378 patients in the PERT era. These findings suggest that it was not PERT activation that improved outcome, but better education and thus improved management of patients with PE among providers in that institution.

# Olin

- PERT was activated and managed care in (57 [15%]) of the 378 patients in the PERT era.
- Better interpretation: not PERT activation that improved outcomes, but rather better **education** and thus improved management of patients with PE among providers in that institution.

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# Outcomes Following Introduction a PERT Program

- Rosovsky et al, MGH 2019- Retrospective cohort pre/post PERT, 2006–2012–16
  - PERT era more likely to receive CDT (14 vs. 1%)
  - No differences in mortality or major bleeding.
- Carroll et al, Harvard 2020 – R/C pre/post PERT 2012-15-2018
  - PERT era increased risk stratification (using biomarkers and ECHO) and CDT
  - No difference in PE-related mortality
  - Similar to Chaudhury et al's experience, only 14.2% of PE patients in the PERT era were actually evaluated by the PERT.
- **While having a PERT is associated with improved delivery of care, not enough evidence to conclude activation of a PERT results in improved clinical outcomes.**

# Does everyone need a PERT?

- Yes, because it's fancy.
- I like all the meetings.
- Two (or more) (smart) heads are better than one.

- No, we are already doing all the things.
- I literally cannot attend another meeting.
- A fool with a tool is still a fool.

# In Conclusion…

- PERT Consortium: to advance the diagnosis, treatment, and outcomes of patients with PE.
- Evidence demonstrates that the PERT model improves delivery and standardization of care of PE patients, particularly those patients with massive and submassive PE.
  - Both acutely and in follow up for continuity of care
- It is not yet clear whether PERTs improve clinical outcomes.
- A large prospective database is currently being compiled by the PERT Consortium.
- Data Analysis will likely further delineate the role of PERTs in the management of intermediate-to-high risk PE patients and help determine in which PE patients activation of a PERT may improve clinical outcomes.

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# Pulmonary Embolism Management: How Important is a PERT?

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**Pulmonary Embolism (PE)**
**Low Risk** → **NO Need to Contact PERT Team**

**Pulmonary Embolism (PE)**
**Intermediate Risk** → See **Pages 2 - 3**

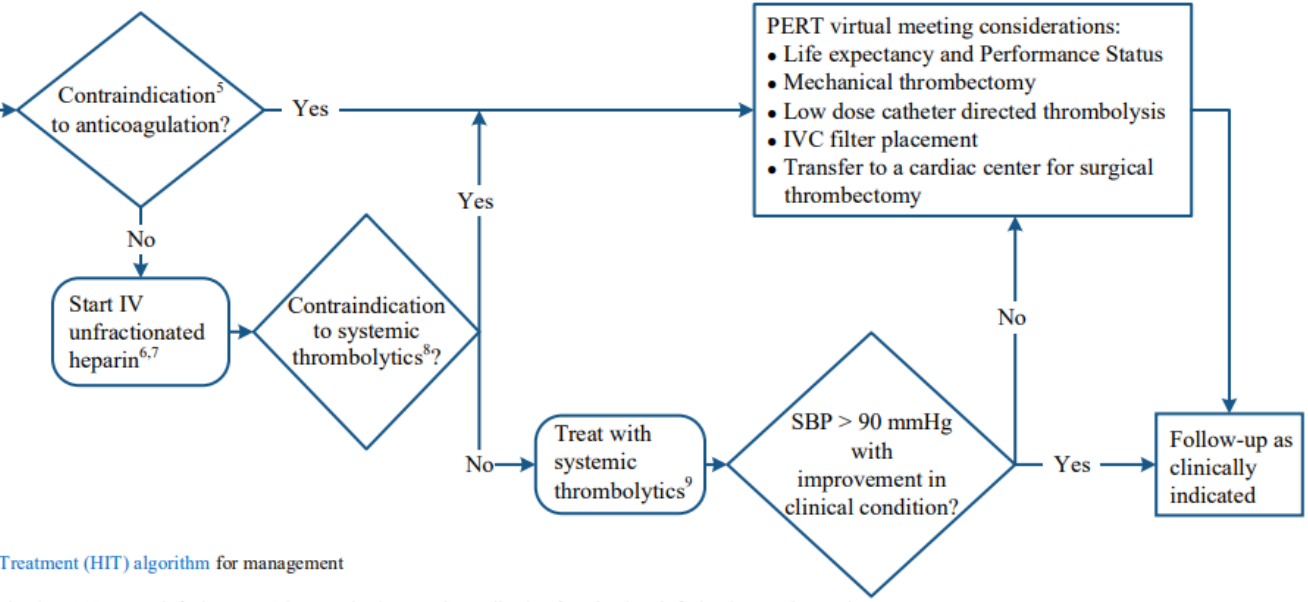
**Pulmonary Embolism (PE)**
**High Risk** → See **Page 4**

## INITIAL EVALUATION – HIGH RISK[1]

PERT First Responder[2] contacted for patient **with Pulmonary Embolism (PE) and High Risk[1]**
- Notify Primary Team (if not already aware of PE)
- For Pediatric considerations, see Appendix B

- Obtain the following (if not already done):
  - NT-proBNP, troponin T, type and screen
  - Routine 2D-ECHO[3]
  - EKG 12-Lead (portable)
  - Ultrasound of leg or venous doppler bilaterally as clinically indicated
- Transfer the patient to ICU
- Initiate a Goal Concordant Care (GCC) conversation[4] with the patient or if clinically indicated, with Surrogate Decision-Maker and the Primary Oncologist/Primary Team/Attending Physician. The Advance Care Planning (ACP) note should be used to document GCC discussion.

## TREATMENT




[1] See Appendix A: Classifications of Pulmonary Embolism
[2] PERT First Responder: On-call fellow/trainee and attending providers
[3] See Appendix C: Criteria for After Hours STAT 2D-ECHO
[4] Refer to GCC home page (for internal use only)
[5] See Appendix D: Contraindications to Anticoagulation Therapy
[6] Refer to Adult Heparin Infusion order set
[7] If patient has a history of HIT, see Heparin Induced Thrombocytopenia Treatment (HIT) algorithm for management
[8] See Appendix F: Contraindications to Systemic Thrombolysis
[9]
- If patient is on heparin infusion, hold heparin infusion and administer alteplase 100 mg IV infusion over 2 hours. Check aPTT immediately after alteplase infusion is complete and restart heparin infusion without bolus if aPTT is ≤ 80 seconds. If aPTT is > 80 seconds, continue to hold heparin infusion and check aPTT every 2 hours until aPTT is ≤ 80 seconds.
- If patient is on LMWH discontinue LMWH and administer alteplase 100 mg IV infusion over 2 hours. Initiate heparin infusion without a bolus at the time of the next scheduled dose of LMWH.
- If patient is on a direct-acting oral anticoagulants (DOAC), discontinue DOAC and administer alteplase 100 mg IV infusion over 2 hours. Initiate heparin infusion without a bolus at the time of the next scheduled dose of DOAC.

## APPENDIX D: Contraindications to Anticoagulation Therapy

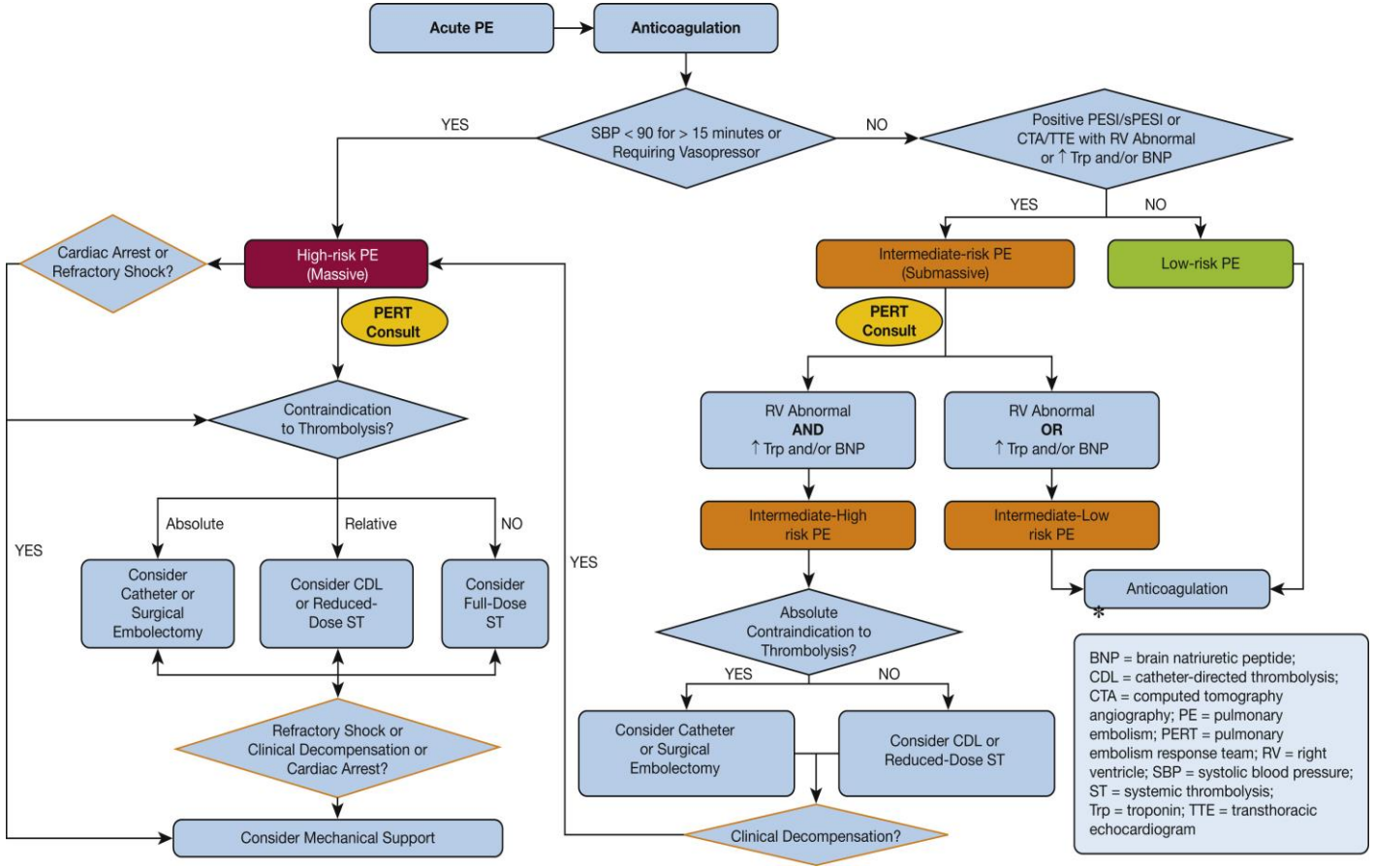
| Absolute Contraindications | Relative Contraindications |
|---|---|
| • Major active bleeding (e.g., bleeding requiring ≥ 2 units of packed red blood cells (PRBC) transfusion, decrease in hemoglobin ≥ 2 g/dL, or bleeding in a critical area or organ)<br>• Platelet < 25 K/microliter, consult to benign hematology<br>• Spinal procedure and/or epidural placement (unless approved by Acute Pain or other appropriate provider)<br>• Severe uncontrolled malignant hypertension | • Brain metastases conferring risk of bleeding (renal, choriocarcinoma, melanoma, thyroid cancer)<br>• Intracranial or central nervous system (CNS) bleeding within the past 4 weeks<br>• Recent high-risk surgery or bleeding event<br>• Active but non-life threatening bleeding<br>• Active GI ulceration at high risk of bleeding<br>• Platelets < 50 K/microliter, consider consult to benign hematology<br>• Patient currently on active protocol that prohibits the use of anticoagulation |

## APPENDIX F: Contraindications to Systemic Thrombolysis

| Absolute Contraindications: | Relative Contraindications: |
|---|---|
| • Active bleeding<br>• History of hemorrhagic stroke or stroke of unknown origin<br>• Intracranial tumor<br>• Ischemic stroke in previous 3 months (if ischemic stroke onset within 4.5 hours, see Management of Acute Ischemic Stroke in Hospitalized Adult Patients algorithm)<br>• Recent brain or spinal surgery[1] and/or head or facial trauma<br>• Suspected or confirmed aortic dissection<br>• Platelet count below 100 K/microliter | • Age > 75 years old<br>• Pregnancy or first post-partum week<br>• Non-compressible puncture sites<br>• Traumatic cardiopulmonary resuscitation<br>• Recent major surgery, invasive procedure, and/or trauma (within 1 month)<br>• Refractory hypertension (SBP > 180 mmHg, DBP > 110 mmHg)<br>• Known bleeding diathesis or acquired coagulopathy<br>• Significant non-intracranial bleeding within 1 month<br>• Life expectancy ≤ 6 months |

SBP = systolic blood pressure
DBP = diastolic blood pressure

[1] Discussion with neurosurgery for recent brain or spinal surgery



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