How to set up a Pulmonary Embolism Program

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Conflicts of Interest

- No financial conflicts of interest
- Clinical investigator for EKOS SEATTLE-II Trial
# Risk Stratification

Patient risk stratification (per AHA 2011 guidelines)

<table>
<thead>
<tr>
<th>Massive PE</th>
<th>Submassive PE</th>
<th>Minor/Nonmassive PE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High risk</strong></td>
<td><strong>Moderate risk</strong></td>
<td><strong>Low risk</strong></td>
</tr>
<tr>
<td>• Sustained hypotension (systolic BP &lt;90 mmHg for ≥15 min)</td>
<td>• Systemically normotensive (systolic BP ≥90 mmHg)</td>
<td>• Systemically normotensive (systolic BP ≥90 mmHg)</td>
</tr>
<tr>
<td>• Inotropic support</td>
<td>• RV dysfunction</td>
<td>• No RV dysfunction</td>
</tr>
<tr>
<td>• Pulselessness</td>
<td>• Myocardial necrosis</td>
<td>• No myocardial necrosis</td>
</tr>
<tr>
<td>• Persistent profound bradycardia (HR &lt;40 bpm with signs or symptoms of shock)</td>
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**RV dysfunction**

- RV/LV ratio > 0.9 or RV systolic dysfunction on echo
- RV/LV ratio > 0.9 on CT
- Elevation of BNP (>90 pg/mL)
- Elevation of NTpro-BNP (>500 pg/mL)
- ECG changes
  - new complete or incomplete RBBB
  - anteroseptal ST elevation or depression

Acute PE: Patient Population Profile

**Massive PE [High risk]**
5% PE population
58% mortality @ 3 months

**Minor PE [Low risk]**
55% PE population
Good prognosis
Low mortality rate

**Submassive PE [Moderate risk]**
40% PE population
21% mortality @ 3 months

Who cares for the PE patients now?

- Hospitalist
- Intensivist/Pulmonologist
- Internist
- Cardiologist
# Catheter Based Thrombolysis (CBT) Candidates

<table>
<thead>
<tr>
<th>Minor</th>
<th>Submassive</th>
<th>Submassive</th>
<th>Submassive</th>
<th>Massive</th>
</tr>
</thead>
<tbody>
<tr>
<td>- No/minor symptoms</td>
<td>- Mild symptoms</td>
<td>- Mild/moderate symptoms</td>
<td>- Moderate symptoms</td>
<td>- Major symptoms</td>
</tr>
<tr>
<td>- Normal hemodynamics</td>
<td>- Normal hemodynamics</td>
<td>- Mild abn hemodynamics</td>
<td>- RV involvement</td>
<td>- Shock</td>
</tr>
<tr>
<td>- Normal RV</td>
<td>- Borderline markers</td>
<td>- Some RV involvement</td>
<td>- Abn biomarkers</td>
<td>- Marked abn markers</td>
</tr>
</tbody>
</table>

Treatment and prognosis of patients with PE depends on the characteristics and distribution of thrombus itself and the underlying health status of the patient. Patients with PE but no hemodynamic instability, RV dysfunction, or myocardial necrosis do well with systemic anticoagulation alone.
Rationale for Fibrinolysis in Acute PE

REDUCE THROMBUS BURDEN (not achievable by AC alone)

⇒ Reverse RV afterload / failure to prevent hemodynamic collapse
⇒ Improve pulmonary reperfusion/capillary blood flow/gas exchange
⇒ Restore systemic arterial perfusion pressure
⇒ Decrease the risk of developing chronic pulmonary hypertension
Fibrinolysis for massive PE

Considered a life-saving intervention:

- Patients presenting in shock or requiring cardiopulmonary resuscitation report 25-65% short-term mortality

Goals:

- Improve systemic arterial perfusion pressure by relieving RV overload
- Avert impending hemodynamic collapse and death due to progressive RV failure
FDA approved fibrinolysis for treatment of acute PE

100 mg rt-PA infused over 2 hours

Indication: treatment of (massive) patients presenting with acute PE and:

- Syncope
- Systemic arterial hypotension
- Cardiogenic shock
- Cardiac arrest

**Contraindications:**

- Intracranial malignancy or mass
- History of intracranial hemorrhage
- Cerebrovascular event or neurosurgical procedure within the prior 2 months
- Surgery, invasive procedure, or internal organ biopsy
- Recent major trauma
- Active or recent respiratory tract, gastrointestinal, or genitourinary bleeding
- Severe uncontrolled hypertension
- Recent prolonged cardiopulmonary resuscitation
- Thrombocytopenia with < 50,000 platelets/μl
- Acute pericarditis or pericardial effusion
- Ongoing suspicion for aortic dissection
PE Program – Patient Inclusion Criteria

- Patients with acute PE symptoms < 14 days with primary focus on patients with symptoms for 3 days or less.
- Filling defect by contrast-enhanced chest CT or VQ scan in at least one main or proximal pulmonary artery
- Massive PE (syncope, systemic arterial hypotension, cardiogenic shock, or resuscitated cardiac arrest) or Submassive PE (defined as either RV diameter-to-LV diameter ≥ 0.9 on contrast-enhanced chest CT or echocardiography; evidence of moderate to severe RV strain such as RV hypokinesis and either RVSP>40 or elevation of cardiac biomarkers such as troponin above borderline value or BNP >100.
PE Program – Patient Exclusion Criteria

- Active bleeding from any major organ.
- Stroke or transient ischemic attack (TIA), head trauma, or other active intracranial or intraspinal disease within the past 3 months unless the physician documents that the benefits outweigh the increased risk in the individual patient with a pulmonary embolism being evaluation for catheter based therapy.
- Major surgery within the last seven days unless the physician documents that the benefits outweigh the increased risk in the patient with a pulmonary embolism being evaluation for catheter based therapy.
- High risk of bleeding or bleeding diathesis including thrombocytopenia (Platelets < 100 thousand/μL), coagulopathy (INR > 3.0 or aPTT > 50 seconds on no anticoagulants), or anemia (Hct < 25%).
- Systolic blood pressure less than 70 mm Hg despite vasopressor or inotropic support. Cardiac arrest (including pulseless electrical activity and asystole) requiring active cardiopulmonary resuscitation (CPR).
- Evidence of irreversible neurological compromise.
Suggested algorithm for the management of acute pulmonary embolism according to the scientific statement of the American Heart Association with the corresponding levels of evidence.

Engelberger R P, Kucher N Circulation 2011;124:2139-2144
Developing a Program

• Identify patients
  • PE is a challenging diagnosis and often missed.
  • Need involvement of nurses, hospitalists, internists, ED physicians, pulmonologists, and critical care medicine. All need to not only identify patients with PE, but then communicate with PE team.

• Identify team to care for patients
  • Need rapid consultation and eligibility for invasive procedure. (Not a STEMI protocol, but need to have available physicians to assess patients)
  • In a busy and viable program ½ of patients will not need or not be indicated for an invasive procedures. (Depends on screening criteria and who is initially evaluating the patients)
  • Need supportive and engaged multidisciplinary team
Catheter Based Thrombolysis - Procedural Team

- **Cath lab**
  - Equipment - need at least two systems available with ability to quickly “borrow” two additional units.
  - Cath lab staff training. Procedure is not difficult nor time consuming.

- **Nursing**
  - Need ICU trained nurses for these patients
  - Comfort with CBT system, catheter removal and thrombolytics.

- **Pharmacy**
  - Need rapid availability of pharmacy for thromolyticis
  - Order sets for EMR. Complex post-procedural orders best done via order sets for nursing instructions and lab draws.
Multidisciplinary Program

- Need hospitalists, internists, ED physicians, pulmonologists, critical care medicine and cardiologists all working together to care for these patients.
- Key is education of the physicians and building a working multidisciplinary physician group
- Will also need nursing, respiratory, pharmacy and IT assistance to build and maintain the program.
- Cost is not a significant issue (unusual for any program) with good procedural reimbursement, shorter patient hospitalization and good outcomes.
Roadblocks

• Any group oppositional to or who doesn’t believe in the procedure or program will markedly hamper the growth and effective treatment of these patients.

• Physician training/comfort with CBT procedure and availability to assess PE patients.

• Cost is not a significant issue, but need to have CBT equipment availability.

• While not a significant roadblock, there does need to be cath lab staff and nursing training.
Three Most Important Aspects of a Pulmonary Embolism Program

- Education
- Education
- Education
MGH Approach – PERT Team (PE Response Team)

- Core faculty from Cardiology, Cardiothoracic Surgery, Echocardiography, Emergency Medicine, Hematology, Pulmonary/Critical Care, and Vascular.
- Telephone (virtual) meeting to discuss cases. Goal to conduct a meeting within 90 minutes of initial PERT activation.
- Unified and coordinated approach with multiple specialists rendering a collaborative recommendation.
- Data gathering for research and building best practices.
PULMONARY EMBOLISM RESPONSE TEAM ACTIVATION

Large Pulmonary Embolus?
For Example:
- PE with abnormal vital signs (tachycardia or hypotension)
- Evidence of right heart strain
- (echo, EKG or positive biomarkers)
- Central or Saddle PE

CALL [ ]
TO ACTIVATE THE
PULMONARY EMBOLISM
RESPONSE TEAM
(PERT)

Please order (unless already done):
- Stat Echocardiogram
- EKG
- CBC, PT/PTT, Creatinine
- Troponin, and NT-proBNP
- Type and Screen

PERT: A Multidisciplinary Team to Coordinate and Expedite Appropriate Treatment of Pulmonary Embolus
Activate for Pulmonary Embolism
PE Rapid Response Team

Don’t monkey around with PE...
Go APE!
Call your Cardiologist!

Signs of PE
- ↑Heart rate
- ↓BP
- Chest pain
- Dyspnea
- ↓O₂ sat

Orders
- CT (PE protocol)
- Echo (RV strain)
- CBC, PT, PTT
- ECG
- Troponin
- D-dimer

Activation
- Call Cardiology
- Decision support
- Care coordination
- Catheter lysis
- New therapies

Know PE
Find PE
Treat PE
Conclusions

• Multidisciplinary approach
• Need hospitalists, critical care medicine, pulmonary, internists, and cardiologists working together.
• Early diagnosis and treatment vital.
• Education, education, education.
• Know which patients to intervene upon and which to treat conservatively.
Questions