Pulmonary Embolism (PE): Evaluation and Initial Management

Goal
Improve patient outcomes through the use of a standardized, collaborative, multidisciplinary, team-based urgent consult to treat massive and submassive PE.

Key Points
For suspected massive PE (hemodynamically unstable patient) or cardiac arrest due to PE, proceed to page 3.
Massive or submassive PE: Activate Pulmonary Embolism Response Team (PERT). Call 6-8111.
For suspected PE in pregnancy, see Algorithm 4.

Algorithm 1. Use of PE Criteria Based on Patient Location at Time of Event

Any Suspicion for PE

Inpatient or ED/Outpatient (OP)?

Calculate Wells Criteria and see Algorithm 2 for additional treatment recommendations

Do any PERC Criteria apply?

Yes

Exclude other clinical etiologies based on clinical judgment and individual signs/symptoms

No

PE Excluded

Pulmonary Embolism Rule-out Criteria (PERC)

<table>
<thead>
<tr>
<th>Criteria</th>
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</thead>
<tbody>
<tr>
<td>Age ≥ 50</td>
</tr>
<tr>
<td>HR ≥ 100 bmp (In pregnant women, HR ≥ 105 bpm)</td>
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<tr>
<td>Room air SaO₂ &lt; 95%</td>
</tr>
<tr>
<td>Prior History of DVT/PE</td>
</tr>
<tr>
<td>Recent trauma or surgery (&lt;4 weeks)</td>
</tr>
<tr>
<td>Hemoptysis</td>
</tr>
<tr>
<td>Exogenous estrogen*</td>
</tr>
<tr>
<td>Unilateral leg swelling</td>
</tr>
</tbody>
</table>

*Etonogestrel/Ethinyl estradiol (NuvaRing) must be included as a source of estrogen when doing the PERC

Patient meets ANY of the above PERC criteria: PE is not ruled out

Patient DOES NOT meet any of the above PERC criteria: There is < 2% risk of PE and therefore, the patient will not benefit from an evaluation for PE
Algorithm 2: Patient PE Risk Stratification Based on Wells Criteria Score

**Calculated Wells Criteria Score**

- **Score>4?**
  - Yes → **PE Likely**
  - No → **PE less likely**

**PE less likely**

- Perform High sensitivity d-dimer* test to rule out PE

**d-dimer Result**

- Positive → **CTPE Study or V/Q scan (if contraindication to CTPE)**
- Negative → **PE excluded. Evaluate for another diagnosis**

**CTPE Study or V/Q scan (if contraindication to CTPE)**

- Confirmed → **PE confirmed; proceed to Algorithm 3**
- Not Confirmed → **Possible repeat CTPE study**
  - Consult with radiology prior to ordering any additional imaging

**Suggested Empiric Treatment - Options:**
- Enoxaparin
- Heparin

*See Appendix A for preferred option and dosing*

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**Wells Criteria: Pretest Probability for PE**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical signs and symptoms of DVT</td>
<td>3.0</td>
</tr>
<tr>
<td>PE is more likely than an alternative diagnosis***</td>
<td>3.0</td>
</tr>
<tr>
<td>HR &gt; 100 bpm</td>
<td>1.5</td>
</tr>
<tr>
<td>Immobilization (≥ 3 days) or surgery in past 4 weeks</td>
<td>1.5</td>
</tr>
<tr>
<td>Previous DVT/PE</td>
<td>1.5</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>1.0</td>
</tr>
<tr>
<td>Malignancy (On treatment, treated in the past 6 months, or palliative)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

***Chest X-ray reviewed, with no reasonable evidence found for alternative diagnosis.

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**Notes**

- Adjust high-sensitivity d-dimer for age among patients ≥ 50 years:
  - (Age x 0.01)
- See Algorithm 4 for d-dimer references.
Algorithm 3. Patient Pulmonary Embolism Severity Stratification

Hemodynamically Stable?

- Yes
  - Hemodynamic instability defined as:
    - SBP < 100 mmHg for >15 minutes (secondary to PE) or requiring pressors
    - Decrease in SBP > 40 mmHg from baseline
    - Cardiac Arrest

  - Normal Troponin (<0.11 ng/mL) AND BNP* AND No RV Strain on TTE or CT?
    - Yes
      - Anticoagulant treatment (Appendix A or Long-Term Oral Anticoagulation)
    - No
      - Submassive PE Risk

- No
  - Massive PE Risk

  - Consider full-dose systemic lytics if no absolute contraindications (Appendix B Lytics Checklist)
  - See OSUWMC Pharmacy for recommendations on the use of alteplase

  - Anticoagulant treatment (Appendix A)

  - Stat consult to PERT; call transfer center at 6-8111

  - Other treatment options may include:
    - Catheter directed lytics
    - Surgical embolectomy
    - ECLS

  - Admit to ICU

Low PE Risk

- Yes
  - Anticoagulant treatment (Appendix A or Long-Term Oral Anticoagulation)

  - Outpatient treatment is appropriate. If warranted, admit to ED, MedEx OBS or monitored unit for observation.

- No
  - Stat consult to PERT; call transfer center at 6-8111

  - PERT to determine need for and facilitate:
    - Placement in PCU or ICU
    - Follow-up monitoring / testing
    - Consideration of escalation of therapy

  - Later hemodynamic deterioration?
    - No
      - Usual care as indicated (Long-Term Oral Anticoagulation)
    - Yes
      - Admission to med/surg monitored unit

Simplified PESI

<table>
<thead>
<tr>
<th>Patient Characteristic</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt; 80</td>
<td>1</td>
</tr>
<tr>
<td>History of cancer</td>
<td>1</td>
</tr>
<tr>
<td>History of chronic cardiopulmonary disease</td>
<td>1</td>
</tr>
<tr>
<td>HR ≥ 110 bpm</td>
<td>1</td>
</tr>
<tr>
<td>SBP &lt; 100 mmHg</td>
<td>1</td>
</tr>
<tr>
<td>O₂ saturation &lt; 90%</td>
<td>1</td>
</tr>
</tbody>
</table>

*BNP - Brain Natriuretic Peptide: 0-100 pg/mL
Algorithm 4: PE in Pregnancy

Pregnant with suspected PE

Hemodynamically Stable?

Yes

Low Risk PE

Leg Symptoms?

Yes

Positive Bilateral LE Ultrasound?

Yes

Begin LMWH (Appendix A)

High Pre-test Probability?

Yes

Wells > 4 (see page 2)

Simplified Revised Geneva Score >4

Third trimester

Unexplained hypoxemia

CTPE Study

Confirmed

Begin LMWH (Appendix A)

Not Confirmed

No PE

No

Positive

d-dimer Result

Negative

No PE

No

Massive or Submassive PE

Stat consult to PERT; call transfer center at 6-8111.

Hemodynamic instability defined as:

- SBP < 100 mmHg for >15 minutes (secondary to PE) or requiring pressors
- Decrease in SBP > 40 mmHg from baseline
- Cardiac Arrest

Low Risk PE

No

*D-dimer Thresholds

- Non-preg: <0.5 mcg/mL
- 1st trimester: <0.75 mcg/mL
- 2nd trimester: <1 mcg/mL
- 3rd trimester: <1.25 mcg/mL

The following tests should be considered for risk stratification after confirmed PE diagnosis:

- Troponin
- Consider BNP

Adapted from: J Emerg Med 2015;49:104-117

Although supported by current literature, this algorithm utilizing d-dimers has not yet been adopted by the American College of Obstetrics and Gynecology, the American College of Emergency Physicians or the American Thoracic Society.

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Additional Considerations

- PE most often missed in obese, young, healthy, hemodynamically stable women on estrogen AND older patients with a good alternative diagnosis
- Sudden onset of chest pain occurs in 39% of PE (+) and 51% of PE (-) patients
- Reproducible chest pain occurs in 20% of PE (+) patients

Inferior Vena Cava (IVC) Filters:
- In patients with acute DVT or PE who are treated with anticoagulants, we recommend against the routine use of an IVC filter.

Follow-Up Recommendations

- 7–14 days post discharge Anticoagulation follow-up
- 3 months post discharge follow-up to determine hypercoagulation testing, direction of anticoagulation, need for repeat ECHO, further follow-up

OSUWMC Tools

Smart Phrases:
- EBPVTEPERC
- EBPVTEPESI
- EBPVTEWELLSCRITERIA

Order Sets:
- OSUWMC PVS: EKOS Device Orders [1775]
- OSUWMC RAD: Post-Procedure Intravascular Lysis [2626]
- OSU IP GEN: Pulmonary Embolism [6222]

References


Quality Measures

- Number of PERT activations

Guideline Authors

- Pulmonary Embolism Response Team

Guideline reviewed by: Critical Care Quality Committee

Date Approved

September 26, 2018. Fourth Edition

Disclaimer: Clinical practice guidelines and algorithms at The Ohio State University Wexner Medical Center (OSUWMC) are standards that are intended to provide general guidance to clinicians. Patient choice and clinician judgment must remain central to the selection of diagnostic tests and therapy. OSUWMC’s guidelines and algorithms are reviewed periodically for consistency with new evidence; however, new developments may not be represented.
Appendix A: Initial Injectable Anticoagulation

<table>
<thead>
<tr>
<th>Massive PE</th>
<th>Submassive PE</th>
<th>Low-Risk PE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Anticoagulation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UFH&lt;sup&gt;a&lt;/sup&gt;,&lt;sup&gt;c&lt;/sup&gt;</td>
<td>UFH&lt;sup&gt;a&lt;/sup&gt;,&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Stop UFH if it has been started prior to the alteplase infusion. Re-initiate UFH at the completion of the alteplase infusion WITHOUT a bolus.</td>
<td>Standard Sliding Scale: 80 units/kg bolus followed by 18 units/kg/hr (if less than 125 kg) or 12 units/kg/hr (if greater than or equal to 125 kg)</td>
<td></td>
</tr>
<tr>
<td>After systemic lysitics&lt;sup&gt;b&lt;/sup&gt;: Standard Sliding Scale: NO BOLUS, start 18 units/kg/hr (if less than 125 kg) or 12 units/kg/hr (if greater than or equal to 125 kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without systemic lysitics: Standard Sliding Scale: 80 units/kg bolus followed by 18 units/kg/hr (if less than 125 kg) or 12 units/kg/hr (if greater than or equal to 125 kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Goal PTT</strong>: Per OSUWMC Established Heparin Therapeutic Range for Standard Sliding Scale</td>
<td><strong>LMWH&lt;sup&gt;a&lt;/sup&gt;,&lt;sup&gt;d&lt;/sup&gt;,&lt;sup&gt;e&lt;/sup&gt;,&lt;sup&gt;f&lt;/sup&gt;</strong></td>
<td><strong>LMWH&lt;sup&gt;a&lt;/sup&gt;,&lt;sup&gt;c&lt;/sup&gt;,&lt;sup&gt;e&lt;/sup&gt;,&lt;sup&gt;f&lt;/sup&gt;</strong></td>
</tr>
<tr>
<td><strong>LMWH&lt;sup&gt;a&lt;/sup&gt;,&lt;sup&gt;d&lt;/sup&gt;,&lt;sup&gt;e&lt;/sup&gt;,&lt;sup&gt;f&lt;/sup&gt;</strong></td>
<td><strong>Preferred if no procedure / intervention planned</strong></td>
<td><strong>LMWH&lt;sup&gt;a&lt;/sup&gt;,&lt;sup&gt;d&lt;/sup&gt;,&lt;sup&gt;e&lt;/sup&gt;,&lt;sup&gt;f&lt;/sup&gt;</strong></td>
</tr>
<tr>
<td>Enoxaparin 1 mg/kg SQ q12h</td>
<td>Goal Anti-Xa: 0.6 – 1 IU/mL (Consider monitoring Anti-Xa levels)</td>
<td></td>
</tr>
<tr>
<td><strong>Ongoing Therapy</strong></td>
<td>Warfarin DOAC LMWH&lt;sup&gt;a&lt;/sup&gt;,&lt;sup&gt;d&lt;/sup&gt;,&lt;sup&gt;e&lt;/sup&gt;,&lt;sup&gt;f&lt;/sup&gt;,&lt;sup&gt;g&lt;/sup&gt;</td>
<td>Warfarin DOAC LMWH&lt;sup&gt;a&lt;/sup&gt;,&lt;sup&gt;d&lt;/sup&gt;,&lt;sup&gt;e&lt;/sup&gt;,&lt;sup&gt;f&lt;/sup&gt;,&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Special Considerations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;sup&gt;a&lt;/sup&gt;HIT: UFH and LMWH contraindicated; options include bivalirudin and argatroban – consult pharmacy for dosing (See Heparin-Induced Thrombocytopenia Guideline)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;sup&gt;b&lt;/sup&gt;Systemic thrombolytics administered or likely to be administered: UFH preferred</td>
<td></td>
<td></td>
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<tr>
<td>&lt;sup&gt;c&lt;/sup&gt;May require procedure/ECMO: UFH preferred</td>
<td></td>
<td></td>
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<tr>
<td>&lt;sup&gt;d&lt;/sup&gt;Cancer: Consider hematology/oncology consult; LMWH may be preferred for ongoing therapy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;sup&gt;e&lt;/sup&gt;Pregnancy: LMWH recommended for ongoing therapy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;sup&gt;f&lt;/sup&gt;CrCl &lt; 30 mL/min: Avoid LMWH; DOACs not preferred for ongoing therapy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;sup&gt;g&lt;/sup&gt;Enoxaparin is not FDA approved for the outpatient treatment of pulmonary embolism.</td>
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</tbody>
</table>

DOAC = Direct Oral Anticoagulant; ECMO = Extracorporeal Membrane Oxygenation; HIT = Heparin-Induced Thrombocytopenia; LMWH = Low Molecular Weight Heparin; UFH = Unfractionated Heparin


### Appendix B: SYSTEMIC THROMBOLYTIC CHECKLIST FOR PULMONARY EMBOLISM COMPLETED PRIOR TO/IN CONJUNCTION WITH PERT CONSULT

Patient/family members understood potential risks and benefits from treatment.

Information Source: □ Patient □ Family _________ □ Outside Medical Record _________

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>General Eligibility for IV treatment with ALTEPLASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Clinical diagnosis of pulmonary embolism</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Hemodynamic instability secondary to PE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SBP &lt; 100 mmHg for at least 15 minutes OR requiring vasopressors OR decrease in SBP &gt; 40 mmHg from baseline</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Cardiac arrest with confirmed or high clinical suspicion for PE</td>
</tr>
</tbody>
</table>

### Contraindications (Answer NO to questions 4-8 to be eligible)

**Absolute contraindications to thrombolysis become relative in patient with cardiac arrest or immediately life-threatening high-risk PE.**

<table>
<thead>
<tr>
<th>No</th>
<th>Contraindication</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Known intracranial neoplasm, arteriovenous malformation or aneurysm</td>
</tr>
<tr>
<td>5</td>
<td>History of hemorrhagic stroke or stroke of unknown origin at any time</td>
</tr>
<tr>
<td>7</td>
<td>Active internal bleeding</td>
</tr>
<tr>
<td>8</td>
<td>Recent major trauma / major surgery / any neurosurgery / head injury /major bleeding within 3 weeks</td>
</tr>
</tbody>
</table>

### Warning/Precaution Considerations

**Use careful consideration and risk vs. benefit analysis. Patient may receive thrombolytic therapy despite ≥ 1 of the below.**

<table>
<thead>
<tr>
<th>No</th>
<th>Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>SBP &gt; 180 mmHg or DBP &gt; 110 mmHg</td>
</tr>
<tr>
<td>10</td>
<td>Known bleeding diathesis or acquired coagulopathies</td>
</tr>
<tr>
<td>11</td>
<td>Platelet count &lt; 100,000/mm³</td>
</tr>
<tr>
<td>12</td>
<td>Therapeutic anticoagulation</td>
</tr>
<tr>
<td>13</td>
<td>Current or recent use of: Ticagrelor (Brilinta®) within last 5 days or Prasugrel (Effient®) within last 7 days</td>
</tr>
<tr>
<td>14</td>
<td>Arterial puncture at non-compressible site, organ biopsy or lumbar puncture within last 7 days</td>
</tr>
<tr>
<td>15</td>
<td>Any history of ischemic stroke</td>
</tr>
<tr>
<td>16</td>
<td>Any neurosurgical procedure within 3 months, consider contacting surgeon to balance risk and benefit</td>
</tr>
<tr>
<td>17</td>
<td>Pregnancy, or within one week postpartum</td>
</tr>
<tr>
<td>18</td>
<td>Low body weight (&lt; 60 kg), consider reduced dose (0.6 mg/kg)</td>
</tr>
<tr>
<td>19</td>
<td>Suspected or known infective endocarditis</td>
</tr>
<tr>
<td>20</td>
<td>Suspected or known pericardial effusion</td>
</tr>
<tr>
<td>21</td>
<td>Age &lt; 18 years old</td>
</tr>
</tbody>
</table>

### Futility Considerations

- Thrombolytic therapy should not be used without a high clinical suspicion for PE as cause of arrest.
- If pursued, thrombolytic therapy should be given as soon as possible after arrest while following routine Advanced Cardiac Life Support (ACLS) resuscitative measures.
- In scenarios where resuscitation may be considered futile, such as patients with unknown down time or prolonged resuscitation, use of thrombolytic therapy may not offer clinical benefit.

### References

- Standard OSUWMC clinical practice.