Pulmonary Embolism Response Team (PERT)

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Pulmonary Embolism (PE)
- Low Risk: NO Need to Contact PERT Team
- Intermediate Risk: See Pages 2 - 3
- High Risk: See Page 4

APPENDIX A: Classifications of Pulmonary Embolism (PE).......................... Page 5
APPENDIX B: Considerations for Pediatric Patients ................................. Page 6
APPENDIX C: Criteria for After Hours STAT 2D-ECHO......................... Page 7
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Pulmonary Embolism Response Team (PERT)

INITIAL EVALUATION – INTERMEDIATE RISK

PERT First Responder contacted for patient with Pulmonary Embolism (PE) and Intermediate Risk
- 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
- EKG 12-Lead (portable)
- Ultrasound of leg or venous doppler bilaterally as clinically indicated

Risk stratification assessed by PESI score:
- Yes
- No

Absolute contraindication to anticoagulation?
- Yes
- No

See Page 3

High-Intermediate Risk PE and PESI score < 86 or Low-Intermediate Risk PE

- Transfer the patient to cardiac monitoring bed
- Observe

High-Intermediate Risk PE and PESI score ≥ 86

- Transfer the patient to ICU
- Initiate a Goal Concordant Care (GCC) conversation 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
- Observe

Temporary contraindication to anticoagulant?
- Yes
- No

Retrievable IVC filter
- Permanent IVC filter

Follow-up as clinically indicated

TREATMENT

A

Yes

No

Observe

Follow-up as clinically indicated

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
https://www.mdapp.co/pulmonary-embolism-severity-index-pesi-score-calculator-118

6 Criteria to consider for placement of a retrievable filter:
- If temporary/limited time (≤ 2-3 months) of contraindication to anticoagulants
- Greater than 6 months survival expected
- Performance Status ≤ 1

7 Refer to GCC home page (for internal use only)

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Pulmonary Embolism Response Team (PERT)

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INITIAL EVALUATION – INTERMEDIATE RISK

No absolute contraindication to anticoagulation

RR ≥ 30 breaths/minute or O₂ saturation on room air < 90% or HR ≥ 110 beats/minute or SBP < 100 mmHg or AMS

Start IV unfractionated heparin

Risk stratification assessed by PESI score

High-Intermediate Risk PE and PESI score ≥ 86

Start LMWH

Low-Intermediate Risk PE

Follow-up as clinically indicated

TREATMENT

• Continue anticoagulation
• Transfer the patient to ICU
• Initiate a Goal Concordant Care (GCC) conversation 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
• Observe

PERT virtual meeting considerations:
• Life expectancy and Performance Status
• Mechanical thrombectomy
• Low dose catheter directed thrombolysis
• IVC filter

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

1See Appendix A: Classifications of Pulmonary Embolism
2See Appendix D: Contraindications to Anticoagulation Therapy
3Refer to Adult Heparin Infusion order set
4If patient has a history of heparin induced thrombocytopenia (HIT), see Heparin Induced Thrombocytopenia (HIT) Treatment algorithm for management
5May consider Low Intensity dosing of IV unfractionated heparin for patients with relative contraindication to anticoagulation therapy (see Appendix D). If the risk is still too high, see Box A on Page 2 for patients with absolute contraindication to anticoagulation.
7Refer to GCC home page (for internal use only)
8See Appendix E: Low Molecular Weight Heparin (LMWH) Regimens for Treatment of Cancer Associated Thrombosis
INITIAL EVALUATION – HIGH RISK

PERT First Responder contacted for patient with Pulmonary Embolism (PE) and High Risk

- Notify Primary Team (if not already aware of PE)
- For Pediatric considerations, see Appendix B

TREATMENT

- Contraindication to anticoagulation?
  - Yes
  - Start IV unfractionated heparin
  - No
  - Contraindication to systemic thrombolytics?
    - Yes
    - Treat with systemic thrombolytics
    - No
    - SBP > 90 mmHg with improvement in clinical condition?
      - Yes
      - Follow-up as clinically indicated
      - No

PERT virtual meeting considerations:
- Life expectancy and Performance Status
- Mechanical thrombectomy
- Low dose catheter directed thrombolysis
- IVC filter placement
- Transfer to a cardiac center for surgical thrombectomy

Contraindication to systemic thrombolysis?

SBP > 90 mmHg with improvement in clinical condition?

Follow-up as clinically indicated

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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 E: 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.
10 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.
11 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.

Approved by The Executive Committee of the Medical Staff on 04/18/2023
## APPENDIX A: Classifications of Pulmonary Embolism (PE)

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

RV = right ventricular  
SBP = systolic blood pressure  
HR = heart rate
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APPENDIX B: Considerations for Pediatric Patients (< 18 years old)

- PESI score was not validated in pediatric patients. To determine PE risk category, level of care, and management – consult general pediatrics. For unstable patients, contact the pediatric intensive care unit provider.
- If heparin is used in the management of pediatric patients, refer to the Pediatric Treatment of VTE with Unfractionated Heparin Infusion order set
- The preferred LMWH in pediatric patients is enoxaparin 1 mg/kg subcutaneous every 12 hours. Doses should be held for platelets < 30 K/microliter
- Dosing of alteplase for pediatrics patients: 0.5 mg/kg/hour IV infusion over 6 hours
- Vital sign considerations for pediatric patients:

<table>
<thead>
<tr>
<th>Age</th>
<th>Normal awake Heart Rate Beats/minute</th>
<th>Normal Respiratory Rate Breaths/minute</th>
<th>Definition of Hypotension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn (up to 1 month)</td>
<td>100-205</td>
<td>30-53</td>
<td>SBP &lt; 60 (applies to 0 to 28 days)</td>
</tr>
<tr>
<td>Infant (1 - 12 months)</td>
<td>100-180</td>
<td>30-53</td>
<td>SBP &lt; 70 (applies to 1 - 12 months)</td>
</tr>
<tr>
<td>Toddler (1 - 2 years)</td>
<td>98-140</td>
<td>22-37</td>
<td>SBP &lt; 70 + (age in years x 2) (applies to 1 - 10 years)</td>
</tr>
<tr>
<td>Preschooler (3 - 5 years)</td>
<td>80-120</td>
<td>20-28</td>
<td>SBP &lt; 70 + (age in years x 2) (applies to 1 - 10 years)</td>
</tr>
<tr>
<td>Child (6 - 11 years)</td>
<td>75-118</td>
<td>18-25</td>
<td>SBP &lt; 70 + (age in years x 2) (applies to 1 - 10 years)</td>
</tr>
<tr>
<td>Adolescent (12 - 18 years)</td>
<td>60-100</td>
<td>12-20</td>
<td>SBP &lt; 90 (applies to &gt; 10 years)</td>
</tr>
</tbody>
</table>

LMWH = low molecular weight heparin
SBP = systolic blood pressure
Relative Contraindications

- Brain metastases conferring risk of bleeding (renal, choriocarcinoma, melanoma, thyroid cancer)
- Intracranial or central nervous system (CNS) bleeding within the past 4 weeks
- Recent high-risk surgery or bleeding event
- Active but non-life threatening bleeding
- Active GI ulceration at high risk of bleeding
- Platelets < 50 K/microliter, consider consult to benign hematology
- Patient currently on active protocol that prohibits the use of anticoagulation

APPENDIX C: Criteria for After Hours STAT 2D-ECHO

<table>
<thead>
<tr>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient has to be seen first by a member of the PERT team in order to confirm that none of the other imaging modalities are possible (CT angiogram or ventilation-perfusion (VQ) scan)</td>
</tr>
<tr>
<td>Patient is hemodynamically unstable (systolic blood pressure (SBP) &lt; 90 mmHg or receiving vasopressors)</td>
</tr>
<tr>
<td>Pulmonary embolism (PE) has to be highly suspected and no other etiology would explain shock (no septic, hemorrhagic or hypovolemic shock)</td>
</tr>
<tr>
<td>PERT team member is to contact and discuss directly the need of the echo with the cardiologist on-call before sonographer is contacted</td>
</tr>
</tbody>
</table>

APPENDIX D: Contraindications to Anticoagulation Therapy

<table>
<thead>
<tr>
<th>Absolute Contraindications</th>
<th>Relative Contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>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)</td>
<td>Brain metastases conferring risk of bleeding (renal, choriocarcinoma, melanoma, thyroid cancer)</td>
</tr>
<tr>
<td>Platelet &lt; 25 K/microliter, consult to benign hematology</td>
<td>Intracranial or central nervous system (CNS) bleeding within the past 4 weeks</td>
</tr>
<tr>
<td>Spinal procedure and/or epidural placement (unless approved by Acute Pain or other appropriate provider)</td>
<td>Recent high-risk surgery or bleeding event</td>
</tr>
<tr>
<td>Severe uncontrolled malignant hypertension</td>
<td>Active but non-life threatening bleeding</td>
</tr>
<tr>
<td></td>
<td>Active GI ulceration at high risk of bleeding</td>
</tr>
<tr>
<td></td>
<td>Platelets &lt; 50 K/microliter, consider consult to benign hematology</td>
</tr>
<tr>
<td></td>
<td>Patient currently on active protocol that prohibits the use of anticoagulation</td>
</tr>
</tbody>
</table>
Notes:
● Patients who tolerate anticoagulation should be continued on it indefinitely or until active cancer resolves

● Patient should be observed closely for bleeding and signs and symptoms of neurological impairment if therapy is administered during or immediately following diagnostic lumbar puncture, epidural anesthesia, or spinal anesthesia

If lab results indicate heparin induced thrombocytopenia, follow management guideline per Heparin Induced Thrombocytopenia (HIT) Treatment algorithm

Multi-dose vials not recommended for home use

DRUG | DOSE / ROUTE / FREQUENCY | MONITORING | DOSE ADJUSTMENTS
--- | --- | --- | ---
**Dalteparin** *(Fragmin®)* *FDA approved for cancer patients*
● Hold in patients with platelets < 25 K/microliter

| Actual Body Weight (kg) | Month 1 200 IU/kg | Months 2-6 150 IU/kg | Baseline: hemoglobin (hgb)/hematocrit (hct), platelet count, aPTT/PT, and serum creatine
  
  Surgical inpatient: hgb/hct and platelet count every 24 hours after starting the LMWH and then every 3 days from day 4-14 unless the LMWH is stopped, or patient is discharged. After day 14, hgb/hct and platelet count at least once weekly.
  
  Medical inpatient: hgb/hct and platelet count at least once weekly
  
  Platelets: Consider reducing the daily dose by 2,500 units when platelets are between 50-100 K/microliter and use with caution in cancer patients when platelets are < 50 K/microliter
  
  For platelet count < 25 K/microliter, hold dalteparin
  
  Renal: If creatinine clearance (CrCl) < 30 mL/minute: adjust dose to obtain anti-Xa level of 0.5-1.5 IU/mL (4-6 hours after fourth dose). Recommend avoiding if CrCl < 20 mL/minute
  
  Weight: Consider obtaining anti-Xa level in patients weighing > 150 kg or < 50 kg, or BMI ≥ 40 kg/m² and adjust dose to obtain anti-Xa level of 0.5-1.5 IU/mL (4-6 hours after fourth dose)

  
  ≤ 56 | 10,000 IU | 7,500 IU |

  57-68 | 12,500 IU | 10,000 IU |

  69-82 | 15,000 IU | 12,500 IU |

  83-98 | 18,000 IU | 15,000 IU |

  ≥ 99 | Consider monitoring anti-Xa levels and adjust dose as needed. Limited data suggests dalteparin 200 IU/kg based on actual body weight (with no dose capping) in one or two divided doses. An alternative option is enoxaparin 1 mg/kg twice daily (see below).

  
  Enoxaparin *(Lovenox®)*

  ● Hold in patients with platelets < 25 K/microliter

  1 mg/kg subcutaneously every 12 hours
  
  Limited data suggest once per day dosing is inferior in cancer patients and may increase risk of bleeding
  
  Limited data suggest dose of 0.75-0.85 mg/kg every 12 hours in obese patients (BMI ≥ 40 kg/m²)

  Same as above

  Platelets: Limited data suggest the following enoxaparin dose modification:
  
  For platelet count > 50 K/microliter: full-dose, 1 mg/kg twice daily
  
  For platelet count 25-50 K/microliter: half-dose, 0.5 mg/kg twice daily
  
  For platelet count < 25 K/microliter, hold all anticoagulants

  Renal: If CrCl < 30 mL/minute: 1mg/kg daily. Recommend avoiding if CrCl < 20 mL/minute

  Weight: Consider obtaining anti-Xa level in patients weighing > 150 kg or < 50 kg, or BMI ≥ 40 kg/m² and adjust dose to obtain anti-Xa level of 0.6-1 IU/mL (4-6 hours after fourth dose)

  1 Notes:
  ● Patients who tolerate anticoagulation should be continued on it indefinitely or until active cancer resolves
  
  ● Patient should be observed closely for bleeding and signs and symptoms of neurological impairment if therapy is administered during or immediately following diagnostic lumbar puncture, epidural anesthesia, or spinal anesthesia

  2 If lab results indicate heparin induced thrombocytopenia, follow management guideline per Heparin Induced Thrombocytopenia (HIT) Treatment algorithm

  3 Multi-dose vials not recommended for home use
APPENDIX F: Contraindications to Systemic Thrombolysis

<table>
<thead>
<tr>
<th>Absolute Contraindications:</th>
<th>Relative Contraindications:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Active bleeding</td>
<td>● Age &gt; 75 years old</td>
</tr>
<tr>
<td>● History of hemorrhagic stroke or stroke of unknown origin</td>
<td>● Pregnancy or first post-partum week</td>
</tr>
<tr>
<td>● Intracranial tumor</td>
<td>● Non-compressible puncture sites</td>
</tr>
<tr>
<td>● 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)</td>
<td>● Traumatic cardiopulmonary resuscitation</td>
</tr>
<tr>
<td>● Recent brain or spinal surgery¹ and/or head or facial trauma</td>
<td>● Recent major surgery, invasive procedure, and/or trauma (within 1 month)</td>
</tr>
<tr>
<td>● Suspected or confirmed aortic dissection</td>
<td>● Refractory hypertension (SBP &gt; 180 mmHg, DBP &gt; 110 mmHg)</td>
</tr>
<tr>
<td>● Platelet count below 100 K/microliter</td>
<td>● Known bleeding diathesis or acquired coagulopathy</td>
</tr>
</tbody>
</table>

SBP = systolic blood pressure  
DBP = diastolic blood pressure  
¹ Discussion with neurosurgery for recent brain or spinal surgery
SUGGESTED READINGS


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This practice consensus statement is based on majority expert opinion of the PERT work group at the University of Texas MD Anderson Cancer Center for the patient population. These experts included:

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| Michael Kroll, MD (Benign Hematology) | Ali Zalpour, PharmD (Pharmacy Clinical Programs) |

*Clinical Effectiveness Development Team

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