Pulmonary Embolism Response Team (PERT)

Disclaimer: This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson’s specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient’s care. This algorithm should not be used to treat pregnant women.

Pulmonary Embolism (PE)
Intermediate Risk → See Page 2

Pulmonary Embolism (PE)
High Risk → See Page 3

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

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

APPENDIX B: Classification of Pulmonary Embolism (PE)

APPENDIX C: Contraindications to Anticoagulation Therapy

APPENDIX D: Low Molecular Weight Heparin (LMWH) Regimens for Treatment of Cancer Associated Thrombosis

APPENDIX E: Contraindications to Systemic Thrombolysis

Suggested Readings

Development Credits
INITIAL EVALUATION – INTERMEDIATE RISK

PERT First Responder<sup>1</sup> contacted for patient with Pulmonary Embolism (PE) and Intermediate Risk<sup>2,3</sup>

- Notify Primary Team if not already aware of PE

Contraindication<sup>1</sup> to anticoagulation?

Yes

- Order NT-proBNP (if not done yet)
- Order Troponin T (if not done yet)
- Request routine 2D-ECHO (if not done yet)<sup>4</sup>
- Type and screen
- EKG 12-Lead (portable)
- Ultrasound of leg or venous doppler bilaterally as clinically indicated (if not done yet)

Start IV unfractionated heparin<sup>6</sup>

No

- Low-Intermediate<sup>3</sup> Risk PE

Low-Intermediate<sup>3</sup> Risk PE

- Transfer to telemetry bed (monitored bed)
- Observe

High-Intermediate<sup>1</sup> Risk PE

- Transfer to ICU
- Observe

High-Intermediate<sup>1</sup> Risk PE

- Continue IV heparin
- Transfer to ICU
- Observe

Low-Intermediate<sup>3</sup> Risk PE

- Change to low molecular weight heparin<sup>7</sup>
- Transfer to telemetry bed (monitored bed)
- Observe

TREATMENT

Temporary contraindication to anticoagulant<sup>2</sup>

Yes

- Transfer to telemetry bed (monitored bed)

No

- Permanent IVC filter

Temporary IVC filter<sup>6</sup>

Yes

- PERT virtual meeting

PERT virtual meeting considerations:

- Life expectancy and Performance Status
- Mechanical thrombectomy
- Low dose catheter directed thrombolysis
- IVC filter

Permanent IVC filter

Follow-up as clinically indicated

Yes

No

Retrievable IVC filter<sup>5</sup>

Temporary IVC filter

Follow-up as clinically indicated

Low-Intermediate<sup>3</sup> Risk PE

- Transfer to telemetry bed (monitored bed)

Low-Intermediate<sup>3</sup> Risk PE

- Order NT-proBNP (if not done yet)
- Order Troponin T (if not done yet)
- Request routine 2D-ECHO (if not done yet)
- Type and screen
- EKG 12-Lead (portable)
- Ultrasound of leg or venous doppler bilaterally as clinically indicated (if not done yet)

Start IV unfractionated heparin<sup>6</sup>

1 PERT First Responder: On-Call fellow/trainee and attending provider

2 See Appendix A: Criteria for After Hours STAT 2D-ECHO

3 See Appendix B: Classification of Pulmonary Embolism

4 See Appendix C: Contraindications to Anticoagulation Therapy

5 Criteria to consider for placement of a retrievable filter
- If temporary/limited time (less than or equal to 2-3 months) of contraindication to anticoagulants, place a retrievable IVC filter
- Greater than 6 months survival expected
- Performance Status less than or equal to 1

6 Refer to Adult Heparin Infusion order set

7 See Appendix D: 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

- Order NT-proBNP (if not done yet)
- Order Troponin T (if not done yet)
- Request routine 2D-ECHO (if not done yet)
- Type and Screen
- EKG 12-Lead (Portable)
- Ultrasound of leg or venous doppler bilaterally as clinically indicated (if not done yet)

Contraindication to anticoagulation?

Yes

No

Start IV unfractionated heparin

Contraindication to systemic thrombolytics?

Yes

No

Treat with systemic thrombolytics

Systolic BP greater than 90 mmHg?

Yes

No

Follow-up as clinically indicated

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

1 PERT First Responder: On-call fellow/trainee and attending providers
2 See Appendix A: Criteria for After Hours STAT 2D-ECHO
3 See Appendix B: Classifications of Pulmonary Embolism
4 See Appendix C: Contraindications to Anticoagulation Therapy
5 Refer to Adult Heparin Infusion order set
6 See Appendix E: Contraindications to Systemic Thrombolysis
7 Alteplase 100 mg IV infusion over 2 hours. Institute or resume parental anticoagulation near the end of or immediately following the alteplase infusion when the partial thromboplastin time returns to twice normal or less.
APPENDIX A: 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 VQ scan)</td>
</tr>
<tr>
<td>● Patient is hemodynamically unstable (Systolic Blood Pressure (SBP) less than 90 mmHg or receiving vasopressors)</td>
</tr>
<tr>
<td>● 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 B: Classifications of Pulmonary Embolism (PE)

<table>
<thead>
<tr>
<th>Risk Levels</th>
<th>Classifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Risk</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>Low-Intermediate Risk</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>High-Intermediate Risk</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>High Risk</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>
## APPENDIX C: Contraindications to Anticoagulation Therapy

<table>
<thead>
<tr>
<th>Absolute Contraindications:</th>
<th>Relative Contraindications:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Cerebral hemorrhage, hemorrhage in the eye or vital organs or a drop in hemoglobin of 2 gm/dL in 24 hours</td>
<td>● Brain metastases conferring risk of bleeding (renal, choriocarcinoma, melanoma, thyroid cancer)</td>
</tr>
<tr>
<td>● Neurosurgery, ocular surgery or intracranial bleeding within past 10 days</td>
<td>● Spinal Procedure and/or epidural placement</td>
</tr>
<tr>
<td></td>
<td>● Major trauma or head trauma</td>
</tr>
<tr>
<td></td>
<td>● Major abdominal surgery within 48 hours</td>
</tr>
<tr>
<td></td>
<td>● Severe hypertension (systolic BP greater than 200 mmHg, diastolic BP greater than 120 mmHg)</td>
</tr>
<tr>
<td></td>
<td>● Endocarditis/pericarditis</td>
</tr>
<tr>
<td></td>
<td>● GI, GU bleeding within past 14 days</td>
</tr>
<tr>
<td></td>
<td>● Preexisting coagulopathy</td>
</tr>
<tr>
<td></td>
<td>● Platelets less than 50 K/microliter</td>
</tr>
<tr>
<td></td>
<td>● Hypersensitivity to heparin, low molecular weight heparin (LMWH) or heparin induced thrombocytopenia</td>
</tr>
<tr>
<td></td>
<td>● Patient on active protocol that prohibits use of anticoagulation</td>
</tr>
<tr>
<td></td>
<td>● Bleeding diathesis</td>
</tr>
</tbody>
</table>
APPENDIX D: Low Molecular Weight Heparin (LMWH)\(^1\) Regimens for Treatment of Cancer Associated Thrombosis

<table>
<thead>
<tr>
<th>DRUG</th>
<th>DOSE / ROUTE / FREQUENCY</th>
<th>MONITORING(^2)</th>
<th>DOSE ADJUSTMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalteparin (Fragmin®)*</td>
<td>Actual Body Weight (kg)</td>
<td>Round to nearest International Units (IU) dose, given subcutaneously daily</td>
<td>• Baseline CBC with platelets, aPTT, PT and serum creatinine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Actual Body Weight (kg)</td>
<td>Month 1</td>
</tr>
<tr>
<td></td>
<td>Less than or equal to 56</td>
<td></td>
<td>57-68</td>
</tr>
<tr>
<td></td>
<td>69-82</td>
<td></td>
<td>15,000 IU</td>
</tr>
<tr>
<td></td>
<td>83-98</td>
<td></td>
<td>18,000 IU</td>
</tr>
<tr>
<td></td>
<td>Greater than or equal to 99</td>
<td>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. Consider monitoring anti-Xa levels and adjust dose as needed.</td>
<td></td>
</tr>
<tr>
<td>Enoxaparin (Lovenox®)</td>
<td>1 mg/kg subcutaneously every 12 hours or 1.5 mg/kg* subcutaneously daily in selected patients</td>
<td>Same as above</td>
<td>• If creatinine clearance less than 30 mL/minute; adjust dose to obtain anti-Xa level of 0.5-1.5 International Units/mL (4-6 hours after fourth dose)</td>
</tr>
<tr>
<td></td>
<td>*Limited data suggest once per day dosing is inferior in cancer patients</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Notes:
- LMWH are preferred agents
- If LMWHs are not accessible, consider switching to warfarin after 5 days of LMWH therapy. Heparin and warfarin therapy should overlap 5 days during the acute management of venous thrombosis.
- 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.
### APPENDIX E: Contraindications to Systemic Thrombolysis

<table>
<thead>
<tr>
<th>Absolute Contraindications:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● History of hemorrhagic stroke or stroke of unknown origin</td>
</tr>
<tr>
<td>● Intracranial tumor</td>
</tr>
<tr>
<td>● Ischemic stroke in previous 3 months</td>
</tr>
<tr>
<td>● History of major trauma, surgery or head injury in previous 3 weeks</td>
</tr>
<tr>
<td>● Platelet count below 100 K/microliter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relative Contraindications:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Pregnancy or first post-partum week</td>
</tr>
<tr>
<td>● Non-compressible puncture sites</td>
</tr>
<tr>
<td>● Traumatic resuscitation</td>
</tr>
<tr>
<td>● Refractory hypertension (systolic blood pressure greater than 180 mmHg; diastolic blood</td>
</tr>
<tr>
<td>pressure greater than 100 mmHg)</td>
</tr>
<tr>
<td>● Advanced liver disease</td>
</tr>
<tr>
<td>● Infective endocarditis</td>
</tr>
<tr>
<td>● Recent GI bleed (last 3 months)</td>
</tr>
<tr>
<td>● Life expectancy less than or equal to 6 months</td>
</tr>
</tbody>
</table>
SUGGESTED READINGS


Pulmonary Embolism Response Team (PERT)

Disclaimer: This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson’s specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient’s care. This algorithm should not be used to treat pregnant women.

DEVELOPMENT CREDITS

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:

Kamran Ahrar, MD (Interventional Radiology)†
Teresa Moon Calderon, MD (Anesthesiology & PeriOper Med)
Saadia Faiz, MD (Pulmonary Medicine)
Cristina Gutierrez, MD (Critical Care & Respiratory Care)
Sajid Haque, MD (Critical Care)
Shonice Holdman, MBA*
Steven Y Huang, MD (Interventional Radiology)
Tam Thi Thanh Huynh, MD (Thoracic & Cardiovascular Surgery)
Michael Kroll, MD (Benign Hematology)
Joshua D Kuban, MD (Interventional Radiology)
Elie Mouhayar, MD (Cardiology)
Amy Pai, PharmD*
George Pismisis, MD (Thoracic & Cardiovasc Surgery)
Terry W Rice, MD (Emergency Medicine)
Sharjeel Sabir, MD (Interventional Radiology)
Boris Sepesi, MD (Thoracic Surgery)
Rahul A Sheth, MD (Interventional Radiology)
Alda L Tam, MD (Interventional Radiology)
Saroj Vadhan, MD (Cytokine & Supportive Oncology)
Carol Wu, MD (Diagnostic Radiology – Thoracic Imaging)
S Wamique Yusuf, MD (Cardiology)
Ali Zalpour, PharmD (Pharmacy Clinical Programs)

† Core Development Team Lead
* Clinical Effectiveness Development Team