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Pulmonary Embolism Response Team (PERT)

**APPENDIX A:** Criteria for After Hours 2D-Echo

**APPENDIX B:** Contraindications to Anticoagulation Therapy

**APPENDIX C:** Unfractionated Heparin Dosing

**APPENDIX D:** Low Molecular Weight Heparin Regimens

**APPENDIX E:** Contraindications to Systemic Thrombolysis

Suggested Readings

Development Credits

See Page 2

See Page 3

NO Need to Contact PERT Team

APPENDIX A: Criteria for After Hours 2D-Echo

APPENDIX B: Contraindications to Anticoagulation Therapy

APPENDIX C: Unfractionated Heparin Dosing

APPENDIX D: Low Molecular Weight Heparin Regimens

APPENDIX E: Contraindications to Systemic Thrombolysis

Suggested Readings

Development Credits

NO Need to Contact PERT Team
INITIAL EVALUATION

PERT First Responder\(^1\) contacted for patient with Pulmonary Embolism (PE) and Intermediate Risk\(^2,3\)
- Notify Primary Team if not already aware of PE

Contraindication\(^4\) to anticoagulation?

- Start IV unfractionated heparin\(^5\)
- Order BNP (if not done yet)
- Order troponin (if not done yet)
- Request routine 2D-Echo (if not done yet)\(^6\)
- Type and Screen
- EKG 12-Lead (Portable)
- Ultrasound Leg Venous Doppler Bilateral (if not done yet)

No

Low-Intermediate\(^6\) Risk PE
- Transfer to Telemetry bed (monitored bed)
- Observe

High-Intermediate\(^7\) Risk PE
- Transfer to ICU
- Observe

High-Intermediate\(^7\) Risk PE
- Change to Low Molecular Weight Heparin\(^9\)
- Transfer to Telemetry bed (monitored bed)
- Observe

Low-Intermediate\(^6\) Risk PE
- Continue IV heparin
- Transfer to ICU
- Observe

TREATMENT

Temporary contraindication to anticoagulant?\(^7\)

Yes

Retrievable IVC filter\(^8\)

No

Permanent IVC filter

Follow-up as clinically indicated

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

**Intermediate (Submassive) PE:** Acute PE without systemic hypotension but with evidence of RV dysfunction or myocardial necrosis, elevated Troponin, RV/LV diameter ratio greater than 1 (by CT or ECHO), elevated BNP.

**Low-Intermediate Risk PE:** PE confirmed and SBP greater than 90 mmHg, with either myonecrosis (elevated BNP or Troponin) OR right heart strain (CT or Echo) present

**High-Intermediate Risk PE:** PE confirmed and SBP greater than 90 mmHg, with both myonecrosis (elevated BNP or Troponin) AND right heart strain (CT or Echo) present

**Low-Contraindication to 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

**Low Molecular Weight Heparin Dosing**

---

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

2 Intermediate (Submassive) PE: Acute PE without systemic hypotension but with evidence of RV dysfunction or myocardial necrosis, elevated Troponin, RV/LV diameter ratio greater than 1 (by CT or ECHO), elevated BNP.

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

4 See Appendix B: Contraindications to Anticoagulation

5 See Appendix C: Unfractionated Heparin Dosing

6 Low-Intermediate Risk: PE confirmed and SBP greater than 90 mmHg, with either myonecrosis (elevated BNP or Troponin) OR right heart strain (CT or Echo) present

7 High-Intermediate Risk: PE confirmed and SBP greater than 90 mmHg, with both myonecrosis (elevated BNP or Troponin) AND right heart strain (CT or Echo) present

8 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

9 See Appendix D: Low Molecular Weight Heparin Dosing
INITIAL EVALUATION

PERT First Responder\(^1\)
contacted for patient with
Pulmonary Embolism (PE)
and High Risk\(^2,3\)
- Notify Primary Team if not
already aware of PE

Contraindication
to anticoagulation?

Yes

- Start IV unfractionated heparin\(^4\)
- Order BNP (if not done yet)
- Order troponin (if not done yet)
- Request routine 2D-Echo (if not done yet)\(^5\)
- Type and Screen
- EKG 12-Lead (Portable)
- Ultrasound Leg Venous Doppler Bilateral (if not done yet)

No

Contraindication
to systemic thrombolytics?\(^5\)

Yes

Treat with systemic thrombolytics

No

Systolic BP greater than 90 mmHg?

Yes

Follow-up as clinically indicated

No

PERT Virtual Meeting considers:
- Life expectancy and Performance Status
- Mechanical thrombectomy
- Low dose catheter directed thrombolysis
- IVC Filter Placement
- Transfer to a cardiac center for surgical thrombectomy

TREATMENT

PERT First Responder: On-call fellow/trainee and attending providers

High Risk (Massive) PE:
- Sustained hypotension (systolic blood pressure less than 90 mmHg for at least 15 minutes) or
- Persistent bradycardia (Heart Rate less than 40 bpm with signs or symptoms of shock)
- Need for inotropic support

Follow-up as clinically indicated

No

1 PERT First Responder: On-call fellow/trainee and attending providers
2 High Risk (Massive) PE:
   - Sustained hypotension (systolic blood pressure less than 90 mmHg for at least 15 minutes) or
   - Persistent bradycardia (Heart Rate less than 40 bpm with signs or symptoms of shock)
   - Need for inotropic support
3 See Appendix A: Criteria for After Hours STAT 2D-ECHO
4 See Appendix C: Unfractionated Heparin Dosing
5 See Appendix E: Contraindications to Systemic Thrombolysis

This practice algorithm has been specifically developed for MD Anderson using a multidisciplinary approach and taking into consideration circumstances particular to MD Anderson, including the following: MD Anderson's specific patient population; MD Anderson’s services and structure; and MD Anderson’s clinical information. Moreover, this algorithm is not intended to replace the independent medical or professional judgment of physicians or other health care providers. This algorithm should not be used to treat pregnant women.

Department of Clinical Effectiveness V1
Approved by The Executive Committee of the Medical Staff on 12/3/2016
APPENDIX A: Criteria for After Hours STAT 2D-ECHO

<table>
<thead>
<tr>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 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>b. Patient is hemodynamically unstable (Systolic Blood Pressure less than 90 mmHg or receiving vasopressors)</td>
</tr>
<tr>
<td>c. PE has to be highly suspected and no other etiology would explain shock (no septic, hemorrhagic or hypovolemic shock)</td>
</tr>
<tr>
<td>d. 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: Contraindications to Anticoagulation Therapy

**Absolute Contraindications:**
- Cerebral hemorrhage, hemorrhage in the eye or vital organs or a drop in hemoglobin of 2 gm/dL in 24 hours
- Neurosurgery, ocular surgery or intracranial bleeding within past 10 days

**Relative Contraindications:**
- Brain metastases conferring risk of bleeding (renal, choriocarcinoma, melanoma, thyroid cancer)
- Spinal Procedure and/or epidural placement
- Major trauma or head trauma
- Major abdominal surgery within 48 hours
- Severe hypertension (systolic BP greater than 200 mmHg, diastolic BP greater than 120 mmHg)
- Endocarditis/pericarditis
- GI, GU bleeding within past 14 days
- Preexisting coagulopathy
- Platelets less than 50 K/microliter
- Hypersensitivity to heparin, low molecular weight heparin (LMWH) or heparin induced thrombocytopenia
- Patient on active protocol that prohibits use of anticoagulation
- Bleeding diathesis
**APPENDIX C: Unfractionated Heparin (UFH) Dosing for BMI less than or equal to 40 kg/m\(^2\)**

<table>
<thead>
<tr>
<th>Weight</th>
<th>Heparin Bolus (IV ~ 80 units/kg)</th>
<th>Initial Infusion Rate (~18 units/kg/hour)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 29 kg</td>
<td>2,000 units</td>
<td>500 units / hour</td>
<td></td>
</tr>
<tr>
<td>29 - 34 kg</td>
<td>2,500 units</td>
<td>600 units / hour</td>
<td></td>
</tr>
<tr>
<td>35 - 40 kg</td>
<td>3,000 units</td>
<td>700 units / hour</td>
<td></td>
</tr>
<tr>
<td>41 - 46 kg</td>
<td>3,500 units</td>
<td>800 units / hour</td>
<td></td>
</tr>
<tr>
<td>47 - 53 kg</td>
<td>4,000 units</td>
<td>900 units / hour</td>
<td></td>
</tr>
<tr>
<td>54 - 59 kg</td>
<td>4,500 units</td>
<td>1,000 units / hour</td>
<td></td>
</tr>
<tr>
<td>60 - 65 kg</td>
<td>5,000 units</td>
<td>1,100 units / hour</td>
<td></td>
</tr>
<tr>
<td>66 - 71 kg</td>
<td>5,500 units</td>
<td>1,200 units / hour</td>
<td></td>
</tr>
<tr>
<td>72 - 78 kg</td>
<td>6,000 units</td>
<td>1,300 units / hour</td>
<td></td>
</tr>
<tr>
<td>79 - 84 kg</td>
<td>6,500 units</td>
<td>1,500 units / hour</td>
<td></td>
</tr>
<tr>
<td>85 - 90 kg</td>
<td>7,000 units</td>
<td>1,600 units / hour</td>
<td></td>
</tr>
<tr>
<td>91 - 96 kg</td>
<td>7,500 units</td>
<td>1,700 units / hour</td>
<td></td>
</tr>
<tr>
<td>97 - 103 kg</td>
<td>8,000 units</td>
<td>1,800 units / hour</td>
<td></td>
</tr>
<tr>
<td>104 - 109 kg</td>
<td>8,500 units</td>
<td>1,900 units / hour</td>
<td></td>
</tr>
<tr>
<td>110 - 115 kg</td>
<td>9,000 units</td>
<td>2,000 units / hour</td>
<td></td>
</tr>
<tr>
<td>116 - 121 kg</td>
<td>9,500 units</td>
<td>2,100 units / hour</td>
<td></td>
</tr>
<tr>
<td>Greater than 121 kg</td>
<td>10,000 units</td>
<td>2,200 units / hour</td>
<td></td>
</tr>
</tbody>
</table>

**Pre Heparin Laboratory Tests**
- CBC with Differential
- Partial Thromboplastin Time (PTT)
- Prothrombin Time

**Timed Laboratory Tests**
- PTT 6 hours after initial bolus or dose change and every 6 hours until 2 consecutive aPTT are at goal. Schedule daily AM PTT once target range is achieved.

**Reminder:** Discontinue all heparin products (heparin flushes, subcutaneous heparin), low molecular weight heparins (enoxaparin, dalteparin), fondaparinux, oral warfarin, rivaroxaban, apixaban, dabigatran, and edoxaban.

**WARNING:** If current or recent epidural, intrathecal or spinal procedure, physician to inform acute pain service.
### APPENDIX C (Continued): Unfractionated Heparin (UFH) Dosing for BMI greater than 40 kg/m²

<table>
<thead>
<tr>
<th>Weight (adjusted body weight)</th>
<th>Heparin Bolus (IV ~ 80 units/kg)</th>
<th>Initial Infusion Rate (~18 units/kg/hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>47 - 53 kg</td>
<td>4,000 units</td>
<td>900 units/hour</td>
</tr>
<tr>
<td>54 - 59 kg</td>
<td>4,500 units</td>
<td>1,000 units/hour</td>
</tr>
<tr>
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</tr>
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</tr>
<tr>
<td>116 - 121 kg</td>
<td>9,500 units</td>
<td>2,100 units/hour</td>
</tr>
<tr>
<td>Greater than 121 kg</td>
<td>10,000 units</td>
<td>2,200 units/hour</td>
</tr>
</tbody>
</table>

*For a patient with a BMI greater than 40, use adjusted body weight to determine heparin initial bolus dose and initial infusion rate.*

**Reminder:** Discontinue all heparin products (heparin flushes, subcutaneous heparin), low molecular weight heparins (enoxaparin, dalteparin), fondaparinux, oral warfarin, rivaroxaban, apixaban, dabigatran, and edoxaban.

**WARNING:** If current or recent **epidural, intrathecal or spinal procedure**, physician to inform acute pain service.

---

**MONITORING**

- Pre Heparin Laboratory Tests
  - CBC with Differential
  - Partial Thromboplastin Time
  - Prothrombin Time

- Timed Laboratory Tests
  - PTT 6 hours after initial bolus or dose change and every 6 hours until 2 consecutive aPTT are at goal. Schedule daily AM PTT once target range is achieved.

---

**Department of Clinical Effectiveness V1**

Approved by The Executive Committee of the Medical Staff on 12/13/2016
## APPENDIX D: LMWH¹ Regimens for Treatment of Cancer Associated Thrombosis

<table>
<thead>
<tr>
<th>DRUG</th>
<th>DOSE / ROUTE / FREQUENCY</th>
<th>MONITORING</th>
<th>DOSE ADJUSTMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalteparin (Fragmin®)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Preferred choice, FDA approved for cancer patients</td>
<td>Round to nearest International Units (IU) dose, given subcutaneously daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Actual Body Weight (kg)</td>
<td>Month 1 200 IU/kg</td>
<td>Month 2-6 150 IU/kg</td>
</tr>
<tr>
<td></td>
<td>Less than or equal to 56</td>
<td>10,000 IU</td>
<td>7,500 IU</td>
</tr>
<tr>
<td></td>
<td>57-68</td>
<td>12,500 IU</td>
<td>10,000 IU</td>
</tr>
<tr>
<td></td>
<td>69-82</td>
<td>15,000 IU</td>
<td>12,500 IU</td>
</tr>
<tr>
<td></td>
<td>83-98</td>
<td>18,000 IU</td>
<td>15,000 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>Consider reducing the daily dose by 50% when platelets are between 20 – 50 K/microliter and to 5,000 International Units when platelets are less than 20 K/microliter.</td>
</tr>
<tr>
<td>*Limited data suggest once per day dosing is inferior in cancer patients</td>
<td></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>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Obtain anti-Xa level in patients weighing greater than 150 kg or less than 50 kg, and adjust dose to obtain anti-Xa level of 1.5 IU/mL (4-6 hours after fourth dose)</td>
<td></td>
</tr>
</tbody>
</table>

¹ NOTES: Low-Molecular Weight Heparins (LMWH) (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:</th>
<th>Relative:</th>
</tr>
</thead>
<tbody>
<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</td>
<td>• Traumatic resuscitation</td>
</tr>
<tr>
<td>• History of major trauma, surgery or head injury in previous 3 weeks</td>
<td>• Refractory hypertension (systolic blood pressure greater than 180 mmHg; diastolic blood</td>
</tr>
<tr>
<td>• Platelet count below 100 K/microliter</td>
<td>pressure greater than 100 mmHg)</td>
</tr>
<tr>
<td></td>
<td>• Advanced liver disease</td>
</tr>
<tr>
<td></td>
<td>• Infective endocarditis</td>
</tr>
<tr>
<td></td>
<td>• Recent GI bleed (last 3 months)</td>
</tr>
<tr>
<td></td>
<td>• Life expectancy less than or equal to 6 months</td>
</tr>
</tbody>
</table>
SUGGESTED READINGS


This practice algorithm has been specifically developed for MD Anderson using a multidisciplinary approach and taking into consideration circumstances particular to MD Anderson, including the following: MD Anderson’s specific patient population; MD Anderson’s services and structure; and MD Anderson’s clinical information. Moreover, this algorithm is not intended to replace the independent medical or professional judgment of physicians or other health care providers. This algorithm should not be used to treat pregnant women.

Pulmonary Embolism Response Team (PERT)

This practice consensus statement is based on majority expert opinion of the PERT work group at the University of Texas MD Anderson Cancer Center. 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, BA
- Steven Y Huang, MD (Interventional Radiology)
- Tam Thi Thanh Huynh, MD (Thoracic & Cardiovasc Surgery)
- Firoze Jameel, MSN, RN, OCN
- Michael Kroll, MD (Benign Hematology)
- Joshua D Kuban, MD (Interventional Radiology)
- Elie Mouhayar, MD (Cardiology)
- George Pisimisis, MD (Thoracic & Cardiovasc Surgery)
- Terry W Rice, MD (Emergency Medicine)
- Sharjeel H Sabir, MD (Interventional Radiology)
- Boris Sepesi, MD (Surgery – Katy)
- 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