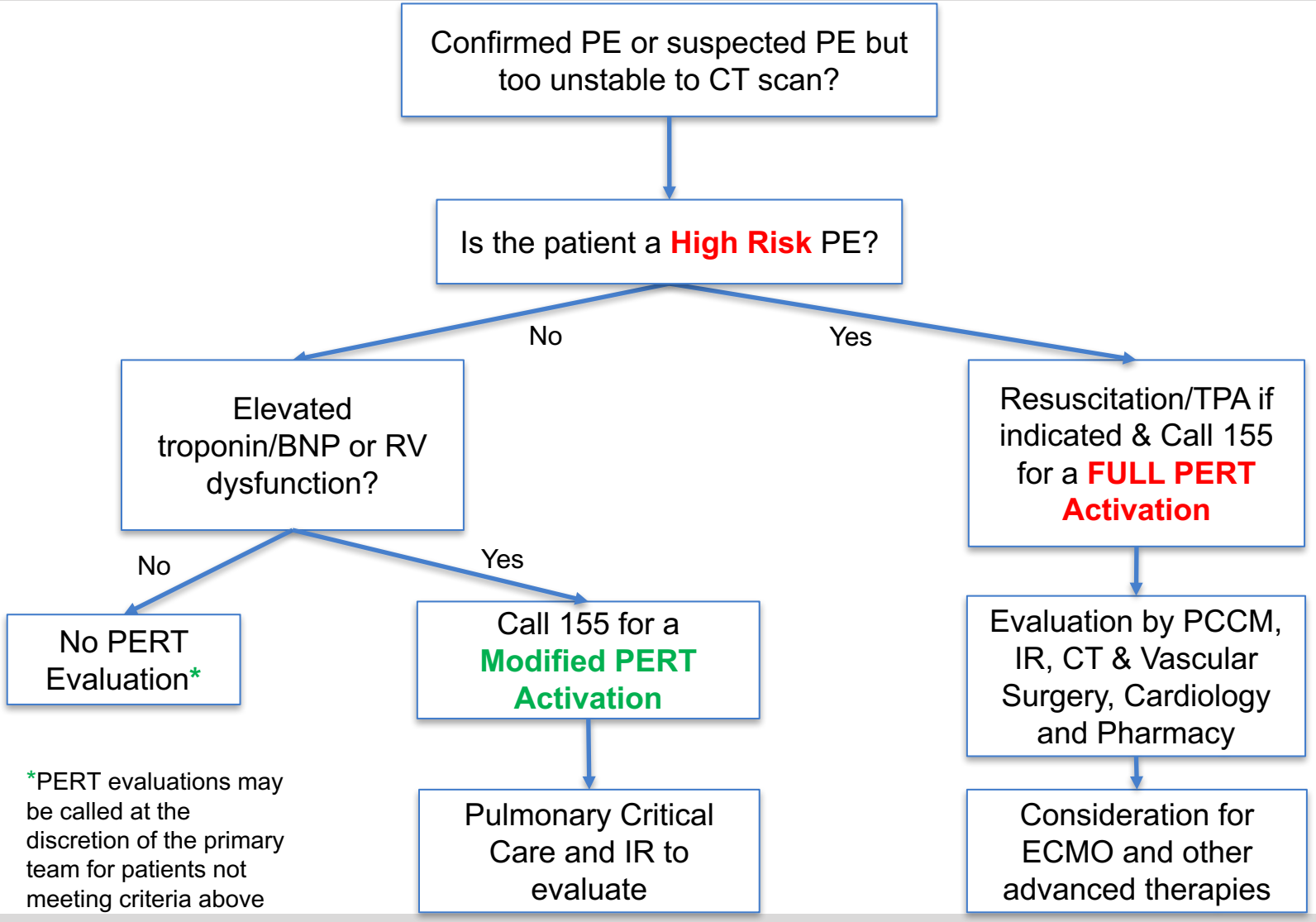
Yale Pulmonary Embolism Response Team

Yale SCHOOL OF MEDICINE

PERT Activation



HIGH RISK
Cardiac Arrest
SBP < 90 mmHg x 2
SBP 40 mmHg or more below baseline
Need for vasopressors to maintain MAP ≥ 65 mmHg, or SBP ≥ 90 mmHg
Mechanical ventilation (or NIMV)
Need for pulmonary vasodilators
Clot in transit or trapped clot in PFO

*PERT evaluations may be called at the discretion of the primary team for patients not meeting criteria above

Modified PERT Activation

- Page will notify both Pulmonary Critical Care and IR
- Pulmonary Critical Care will evaluate the patient and make formal recommendations about treatment/management (evaluate within 30 minutes of page)
- IR to review images and to assess for potential IR guided therapies if indicated
- Pulmonary Critical Care and IR should discuss activations as part of the shared decision making process of a PERT
- 155
  - Modified + Pulmonary Embolism Response Team + Location + CB#

FULL PERT Activation

- Allows for a high-risk/massive PE risk pathway to mobilize multiple resources simultaneously for high risk patients
- Involves PCCM/Intensivist, IR, Cardiothoracic & Vascular Surgery, Cardiology, and Pharmacy
  - Critical Care is the point-person for Full PERTs
- Immediate assessment for: VA-ECMO and other advanced therapies including IR or surgical embolectomy, pulmonary vasodilators, vasopressors, fluids, and IV access
- If patient is an ECMO candidate prefer to cannulate in IR suite/OR if stable for transfer
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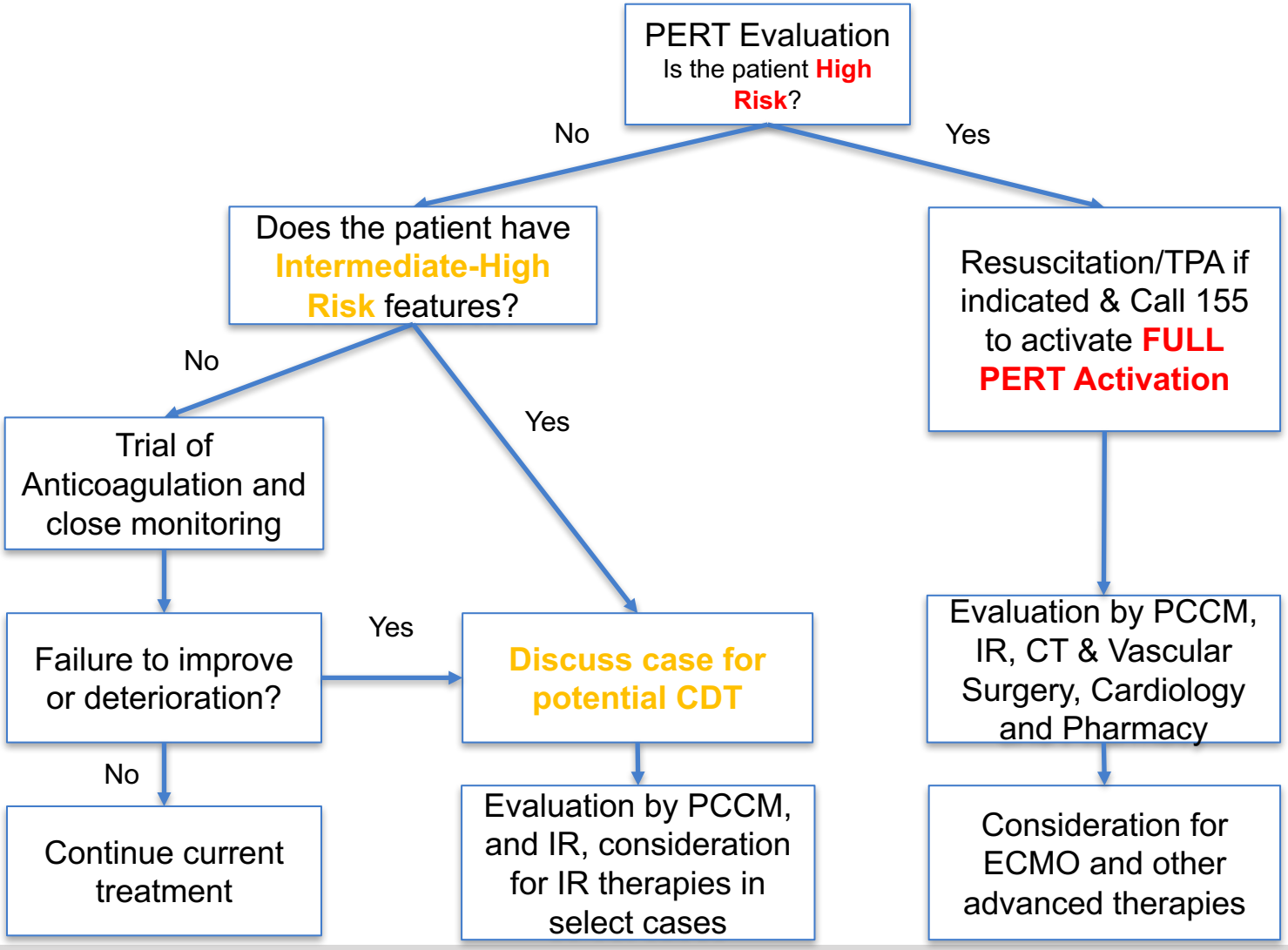
  - FULL + Pulmonary Embolism Response Team + Location + CB#
  - Overhead call = Medical Alert + Full Pulmonary Embolism Response Team + Location

PERT Treatment Workflow Reference



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Clot in transit or trapped clot in PFO

INTERMEDIATE WITH HIGH RISK FEATURES
Near Syncope or Syncope
Sustained (>6 hours) SBP 90 – 100 or pulse > 110 or shock index (pulse / SBP) > 1
Poor Oxygenation - Sat < 95% on 40% FiO2 (or more), or Sat < 90%
LA ≥ 2.5
Significant RV Strain / hypokinesis on CT or TTE (e.g. McConnell's sign), Reduced TAPSE, S'
Troponin T > 0.1 or I >0.4
Pregnancy
BOVA score stage III/>4points

Treatment for Low and Intermediate Risk PE

Consider trial of anticoagulation (AC) for stable patients with:

- Low-risk PE (negative cardiac biomarkers and no evidence of RV dysfunction on CT/TTE)
- Intermediate-low risk PE (positive cardiac biomarkers or evidence of RV dysfunction on CT/TTE)
- Intermediate-high risk PE (positive cardiac biomarkers and evidence of RV dysfunction on CT/TTE) – without high risk features and with minimal symptoms
- Consider Lovenox as first line AC for these patients rather than Heparin
- Consider monitoring on AC in the SDU/MICU for intermediate high risk patients with plan for CDT or systemic lytic therapy if evidence of deterioration

***All cases should be discussed between Pulmonary Critical Care and IR**

When to consider Catheter Directed Therapy (CDT) in Intermediate Risk PE

Consider CDT for patients with confirmed PE and high risk features:

- Near Syncope or Syncope
- SBP 90 – 100 or sustained pulse > 110 or shock index (pulse / SBP) > 1 for 6 hours
- Poor Oxygenation - Sat < 95% on 40% FiO2 (or more), or Sat < 90%
- LA > = 2.5
- Significant RV Strain / hypokinesis on CT or TTE (e.g. McConnell's sign), Reduced TAPSE, S'
- Significantly elevated Troponin T (>0.1) or Troponin I (>0.4)
- Pregnancy
- BOVA score stage III/>4points
- Limited reserve secondary to comorbid conditions
- Deterioration despite initial treatment
- Increasing oxygen or hemodynamic support, worsening RV dysfunction
- Contraindications to anticoagulation and/or systemic thrombolytics

***All cases should be discussed between Pulmonary Critical Care and IR**

Relative Contraindications to Flowtriever

- Chronic clot – symptoms > 14 days or concern for CTEPH
- Active clot in transit
- Significant comorbid conditions/limited life expectancy
- Severe contrast allergy
- Use in caution with patients who have evidence of PFO

High Risk/Massive Pathway – CODE/FULL PERT

- Rapid assessment of unstable PE patients
  - Maintaining SpO2 > 90%, caution with IVF, avoid hypotension
- Systemic thrombolytic (ST)/TPA for massive PE if no contraindications
  - If contraindications to TPA consider IR guided CDT
- Consider ECMO for:
  - Cardiac arrest in the setting of PE
  - Persistent shock
  - Refractory hypoxia
  - Contraindication to TPA
  - Bridge to CDT in a high-risk patient
  - Ideally cannulate in IR suite/OR suite followed by thrombectomy
- Consider CDT for:
  - Contraindications to ST therapy
  - Minimal improvement post ST
  - Large proximal clot burden

High Risk/Massive Pathway – CODE/FULL PERT

- Obtain definitive IV access (save femoral sites for ECMO and IR access)
- If considering ECMO – right radial/axillary arterial line is preferred over left sided and femoral lines given ECMO circulation
- Heparin preferred agent for CODE PERTs as it allows for better monitoring of PTT, ACT and reversal if needed
- TPA is not a contraindication to ECMO or IR guided thrombectomy
- Consider inhaled pulmonary vasodilator for high risk/massive PE
- Caution with intubation – high risk for peri-intubation arrest

When To Consider IVC Filter

- IVCf is indicated for known VTE and contraindications to AC
- Routine use of IVCf for all PE patients not recommended, but IVCf may be considered in select patients (high-risk/massive, intermediate-high with concomitant proximal DVT)
  - Registry studies have revealed lower rates of recurrent PE and mortality in patients with high-risk/massive PE + IVCf
- Consider IVCf in intermediate/sub-massive PE with high-risk features or with:
  - Concomitant proximal DVT
  - PFO
  - Patients at risk of hemodynamic collapse
- Favor placing this at the time of CDT

*All acute cases should be discussed between Pulmonary/Critical Care and IR

When To Consider TTE for PE?

- Consider obtaining TTE urgently/after hours only if you suspect TTE will have an immediate impact on treatment such as:
  - Evaluation of shunt physiology or PFO
  - Clot in transit
  - Potential chronic RV dysfunction or CTEPH rather than acute RV dysfunction
  - To help determine degree of RV strain/dysfunction if equivocal findings on exam and CT
  - Assess for alternative etiologies for shock
  - High risk/massive PE

- Consider obtaining a TTE during day hours rather than overnight if the echo is not going to change immediate management

- TTE is preferred prior to IR guided interventions but is not considered mandatory

- If possible obtain TTE on Full PERTs and on a case by case basis for Modified PERTs

Obtaining a TTE

- Full PERTs
  - Alert sent to Cardiology as part of the activation process
- Modified PERTs
  - Order to be placed by primary team on a case by case basis after discussion with IR and Pulmonary Critical Care
- After-hours (8PM to 730AM)
  - YSC: TTE order to be placed + page on call Cardiology Fellow
    - TTE to be completed by cardiology fellow
  - SRC: TTE order to be placed + page on call Cardiology Fellow
    - TTE to be completed by echo sonographer
  - Pulmonary Critical Care or primary team to assist in completing bubble studies if needed

Cardiac Arrest and PE

Some patients will present in cardiac arrest or deteriorate to cardiac arrest despite appropriate treatment

TPA dose during arrest:

- Notify pharmacy to release TPA
- 50mg bolus over 2 minutes, can be repeated
- Ensure working IV/IO
- Continue CPR with minimal interruptions to ensure drug circulation
  - consider using ETCO2 changes rather than rhythm checks/stopping compressions for the first two rounds of CPR post TPA to maximize drug circulation
- Consider ECMO intra/post arrest to buy time for definitive therapy

Other Considerations

- When accepting patients through Y-axis consider accepting patients to YSC if patient is at risk for requiring a CODE/Full PERT activation
- Consider using Lovenox rather than Heparin for patients who do not meet CODE/Full PERT/High Risk activation and who do not have a high bleed risk
- Patients who meet criteria for intermediate-high and high risk should have outpatient Pulmonary and/or IR follow up scheduled prior to discharge
  - Pulmonary Fellow to help arrange outpatient follow up

Therapies offered at YNNH

Support	Treatment	Prevention
HFNC, NIV, MV	Systemic TPA	Anticoagulation
Pulmonary Vasodilators (iNO*, Veletri)	EKOS (catheter directed thrombolysis)	IVCF
Vasopressors/Inotropes	FlowTriever (catheter directed thrombectomy)	
Mechanical Support: ECMO**	Surgical embolectomy/thrombectomy**	

*iNO at YSC

**ECMO and Surgical thrombectomy at YSC

YSC PERT Pager List 7AM – 7PM

MODIFIED PERT:		**FULL PERT**:	
Employee	Cell Phone & Provider (Or Beeper Number)	Employee	Cell Phone & Provider (Or Beeper Number)
Pulmonary Consult Fellow – YSC		Pulmonary Consult Fellow – YSC	
YM Pulmonary Consult YNHH (Dynamic Role)		YM Pulmonary Consult YNHH (Dynamic Role)	
MICU Admitting - YSC		MICU Admitting - YSC	
IR Level 1 Alert Pager		IR Level 1 Alert Pager	
IR Consult Pager - YSC		IR Consult Pager - YSC	
IR Boardmaster - YSC		IR Boardmaster - YSC	
Interventional Radiology Consult Pager		Interventional Radiology Consult Pager	
Charge Nurse Cath Lab HVC - YSC		Emergency Department Pharmacy	
		Charge Nurse Cath Lab HVC - YSC	
		ECHO Imaging Fellow - YSC	
		Pharmacy Code Pager – YSC	
		CT Surgery ECMO***	
		CT Resident on Call	
		Vascular Surgery***	
		Pharmacy Satellite – Critical Care Medicine	
		OSCE OFF shift clinical executive – YSC	

YSC PERT Pager List 7PM – 7AM

MODIFIED PERT:		**FULL PERT**:	
Employee	Cell Phone & Provider (Or Beeper Number)	Employee	Cell Phone & Provider (Or Beeper Number)
MICU Admitting - YSC		MICU Admitting - YSC	
IR Level 1 Alert Pager		IR Level 1 Alert Pager	
IR Consult Pager - YSC		IR Consult Pager - YSC	
IR Boardmaster - YSC		IR Boardmaster - YSC	
Interventional Radiology Consult Pager		Interventional Radiology Consult Pager	
Charge Nurse Cath Lab HVC - YSC		Emergency Department Pharmacy	
		Charge Nurse Cath Lab HVC - YSC	
		ECHO Imaging Fellow - YSC	
		Pharmacy Code Pager – YSC	
		CT Surgery ECMO***	
		CT Resident on Call	
		Vascular Surgery***	
		Pharmacy Satellite – Critical Care Medicine	
		OSCE OFF shift clinical executive – YSC	

SRC PERT Pager List 7AM-7PM

MODIFIED PERT:		**FULL PERT**:	
Employee	Cell Phone & Provider (Or Beeper Number)	Employee	Cell Phone & Provider (Or Beeper Number)
Pulmonary Intensivist Attending – SRC		Pulmonary Intensivist Attending – SRC	
Pulmonary Fellow -SRC		Pulmonary Fellow -SRC	
YM Pulmonary Consult SRC (Dynamic Role)		YM Pulmonary Consult SRC (Dynamic Role)	
Pulmonary Consult - SRC		Pulmonary Consult - SRC	
IR Consult Pager - SRC		IR Consult Pager - SRC	
IR Level 1 Alert Pager		IR Level 1 Alert Pager	
SRC IR Charge Nurse - YNHH		SRC IR Charge Nurse - YNHH	
IR Boardmaster - SRC		Emergency Department Pharmacist	
		Pharmacy Code Pager - SRC	
		ECHO Imaging Fellow - SRC	
		Cardiac Diagnostic Unit ECHO - SRC	
		IR Boardmaster – SRC	
		CT Surgery ECMO***	
		CT Resident on Call	
		Vascular Surgery***	
		OSCE OFF shift clinical executive – SRC	

SRC PERT Pager List 7PM-7AM

MODIFIED PERT:		**FULL PERT**:	
Employee	Cell Phone & Provider (Or Beeper Number)	Employee	Cell Phone & Provider (Or Beeper Number)
Pulmonary Intensivist Attending – SRC		Pulmonary Intensivist Attending – SRC	
Pulmonary Consult - SRC		Pulmonary Consult - SRC	
IR Consult Pager - SRC		IR Consult Pager - SRC	
IR Level 1 Alert Pager		IR Level 1 Alert Pager	
SRC IR Charge Nurse - YNHH		SRC IR Charge Nurse - YNHH	
IR Boardmaster - SRC		Emergency Department Pharmacist	
		Pharmacy Code Pager - SRC	
		ECHO Imaging Fellow - SRC	
		Cardiac Diagnostic Unit ECHO - SRC	
		IR Boardmaster – SRC	
		CT Surgery ECMO***	
		CT Resident on Call	
		Vascular Surgery***	
		OSCE OFF shift clinical executive – SRC	