

Risk-based treatment of PE



Thomas Metkus MD PhD
Cardiologist, intensivist, echocardiographer
Director of Cardiac Critical Care, JHM and CICU, JHH
Assistant Professor of Medicine and Surgery
Cardiology and Cardiac Surgery, Departments of Medicine & Surgery
Associate Faculty, Armstrong Institute for Patient Safety and Quality



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Learning objectives

- Risk-stratify patients with acute pulmonary embolism into low, intermediate and high risk classes
- Prescribe specific PE treatments depending on risk class: anticoagulation
- Understand principles of effective PE management at the systems level: PERT teams



72 year old woman

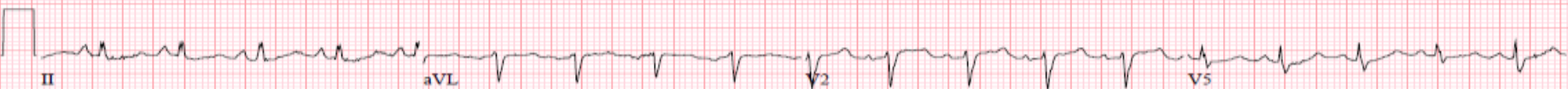
- Good background health
- 5 days prior: R rotator cuff repair, arthroscopic
- 2 days prior: progressive left calf and leg pain with a cramping character that resolved spontaneously
- 1 day prior: nausea, malaise, dyspnea on exertion;
- *Angor animi*
 - To ER
 - Vitals in triage: HR 128, BP 73/43, RR 34, SpO2 88% RA



Physical exam

- General: uncomfortable, ill appearing moaning, drowsy
- JVP: 18 cm H₂O
- Pulses low volume, thready
- Extremities cool; skin ashen
- Lungs clear
- Cor: tachycardic and regular, S1: 1/6 HSM Lps: S2: soft s3 Lps



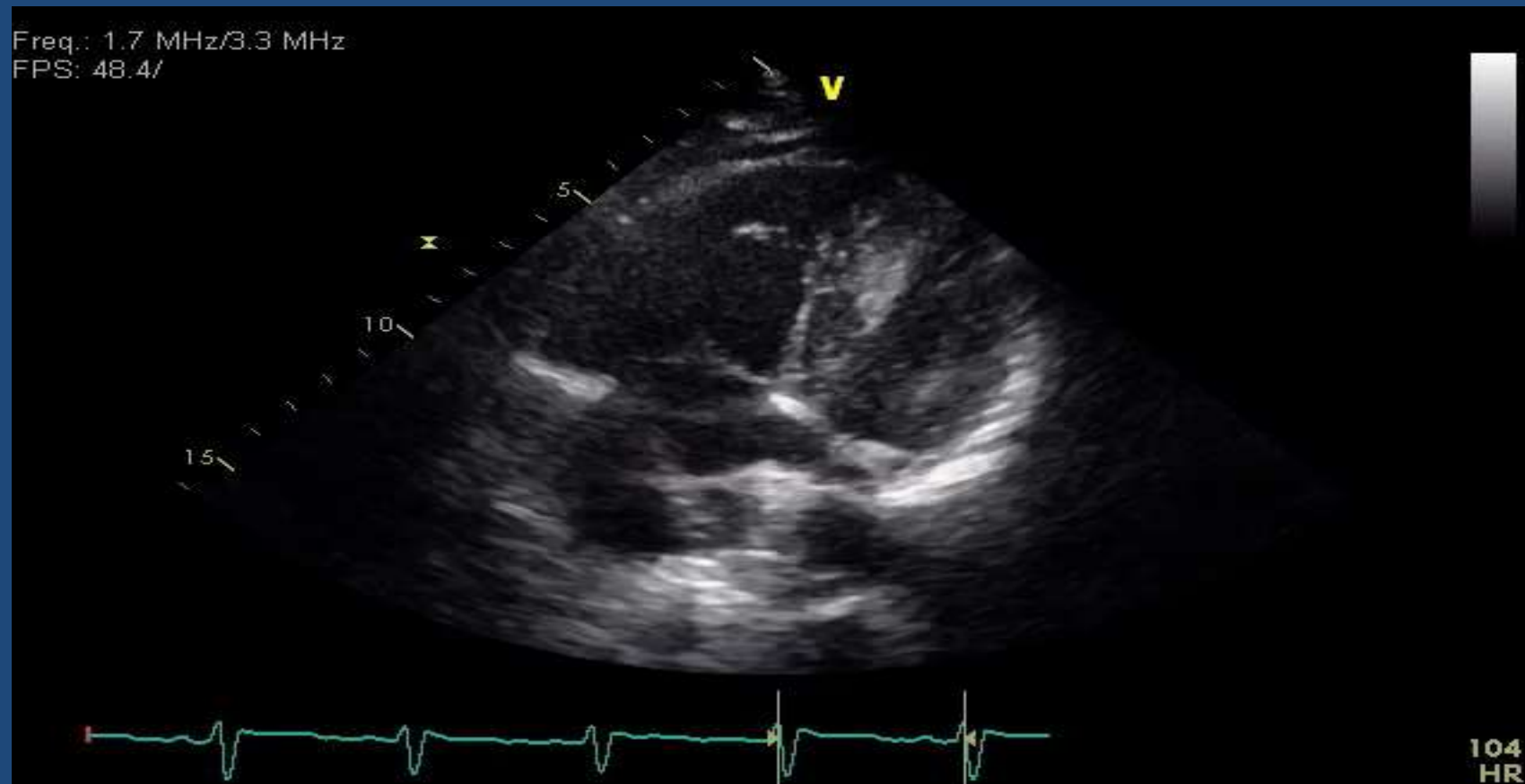


Labs

- ABG: pH 7.45/ pCO₂ 24/ pO₂ 65/ HCO₃ 16 on 3L NC
- CBC WBC 9/ Hgb 12.0/ Hct 37.8/ Plt 178
- BUN 46, Cr 1.9
- Tn 0.28
- BNP 1278
- Lactate 6.5

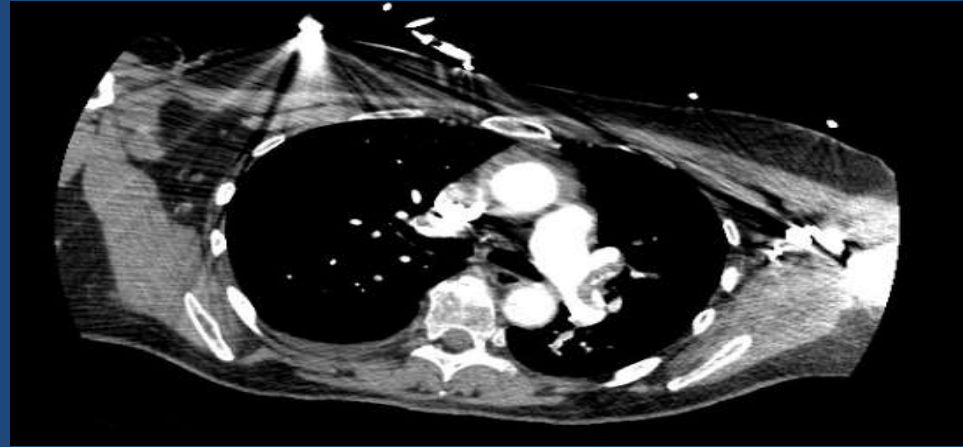
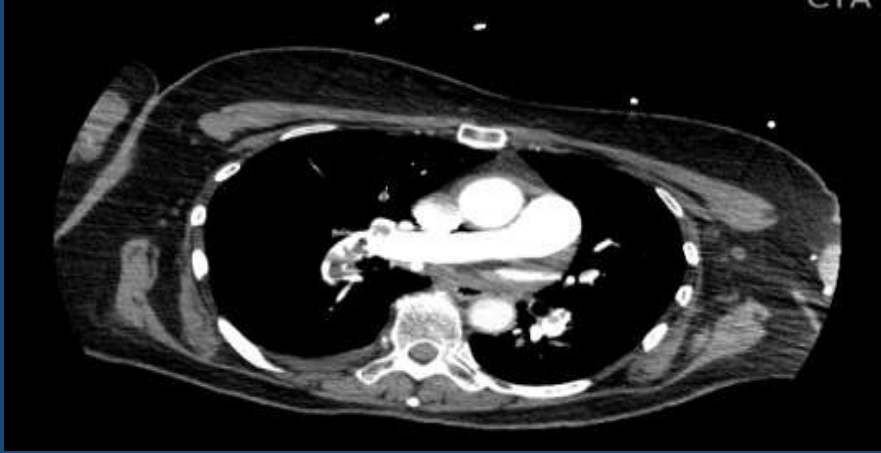


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CT Pulmonary Angiogram

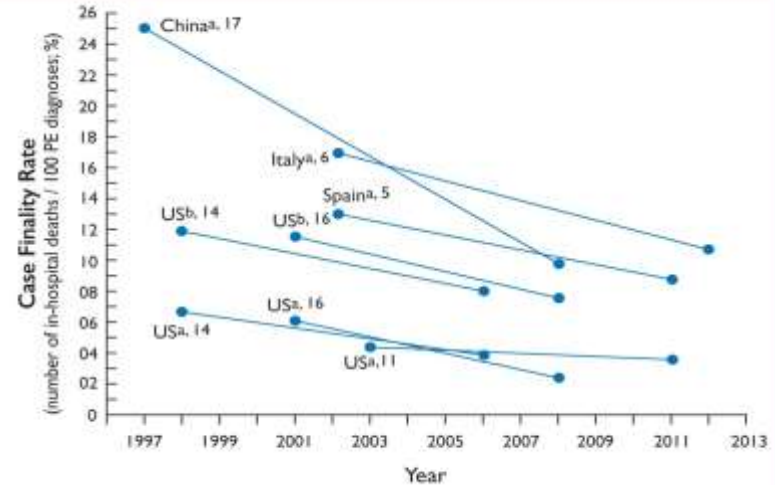
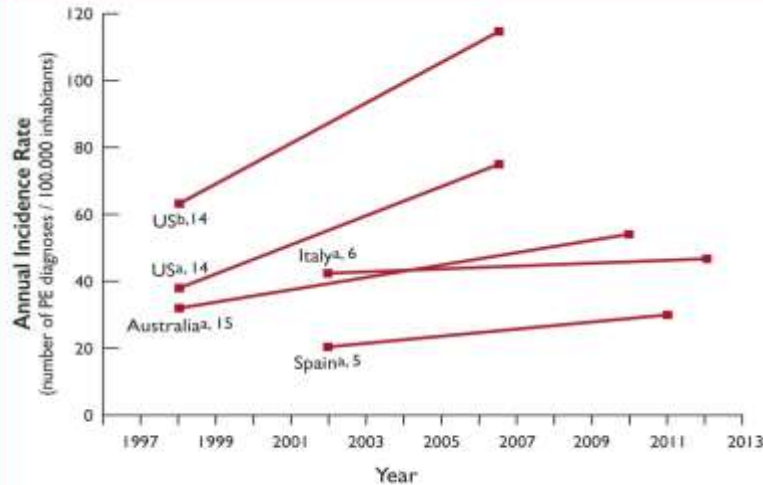


Questions that arise...

- Is her PE low, intermediate or high risk?
 - (“massive, sub-massive, low risk”)
 - Shock, RV dysfunction, biomarkers, H&P
- How should she be treated acutely?



Epidemiology



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Toolkit for acute risk stratification

- History and physical exam
 - HR, pulse pressure, syncope hx, gen. appearance
 - Contraindications to AC, lytics, procedural options
- Labs: troponin, indices of end-organ function
- Echo: TTE/TEE... available and rapid, bedside
- CTPA



Risk spectrum

Early mortality risk		Indicators of risk			
		Haemodynamic instability ^a	Clinical parameters of PE severity and/or comorbidity: PESI class III–V or sFESI ≥1	RV dysfunction on TTE or CTPA ^b	Elevated cardiac troponin levels ^c
High		+	(+) ^d	+	(+)
Intermediate	Intermediate–high	–	+ ^e	+	+
	Intermediate–low	–	+ ^e	One (or none) positive	
Low		–	–	–	Assessment optional; if assessed, negative

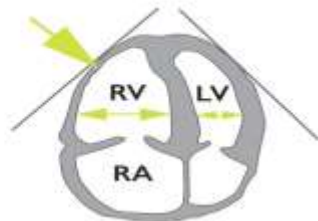
Parameter	Original version ^{22b}	Simplified version ^{22b}
Age	Age in years	1 point (if age >80 years)
Male sex	+10 points	–
Cancer	+30 points	1 point
Chronic heart failure	+10 points	1 point
Chronic pulmonary disease	+10 points	
Pulse rate ≤110 b.p.m.	+20 points	1 point
Systolic BP <100 mmHg	+30 points	1 point
Respiratory rate >30 breaths per min	+20 points	–
Temperature <36°C	+20 points	–
Altered mental status	+60 points	–
Arterial oxyhaemoglobin saturation <90%	+20 points	1 point

- cardiac arrest, obstructive shock), or persistent hypotension

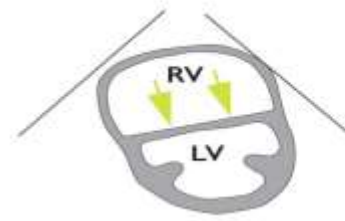




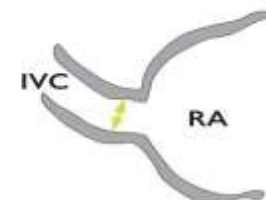
A. Enlarged right ventricle, parasternal long axis view



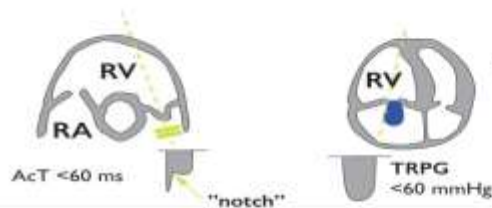
B. Dilated RV with basal RV/LV ratio >1.0 , and McConnell sign (arrow), four chamber view



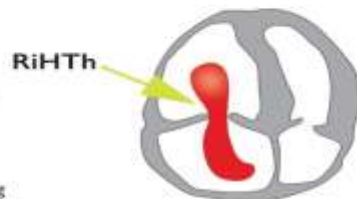
C. Flattened intraventricular septum (arrows) parasternal short axis view



D. Distended inferior vena cava with diminished inspiratory collapsibility, subcostal view



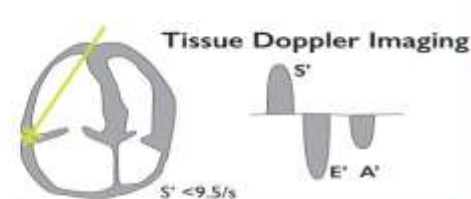
E. 60/60 sign: coexistence of acceleration time of pulmonary ejection <60 ms and mid-systolic "notch" with mildly elevated (<60 mmHg) peak systolic gradient at the tricuspid valve



F. Right heart mobile thrombus detected in right heart cavities (arrow)



G. Decreased tricuspid annular plane systolic excursion (TAPSE) measured with M-Mode (<16 mm)



H. Decreased peak systolic (S') velocity of tricuspid annulus (<9.5 cm/s)

Pearls in risk assessment

- Narrow pulse pressure
- Tachypnea
- Pallor, cool extremities
- diaphoresis
- Syncope or presyncope
- Right heart clot +/- PFO
- Nausea, vomiting
- Angor animi



Pearls in ICU management

- Avoid excessive volume loading
- Avoid acidosis and hypoxemia
- Norepi is vasopressor of choice
- Consider inhaled pulmonary vasodilators
- Noninvasive respiratory support preferred: HFNC > PPV
- PPV with caution
- Intubation with extreme caution and only if truly needed
- Move rapidly to reperfusion/destination therapy



Toolkit for treatment

- All: anticoagulation
- High risk: systemic lytic/surgical embolectomy/catheter based therapy/ECMO
- Intermediate: selective reperfusion therapy
- Rarely: IVC filters



Anticoagulation matters!

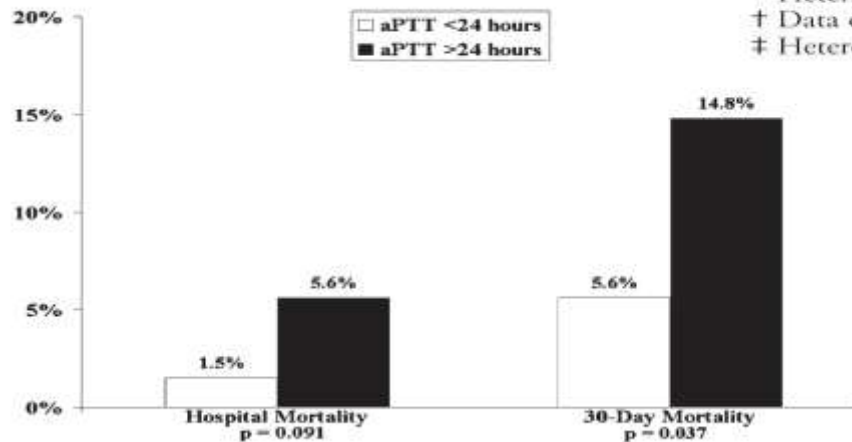
Table 4. Major and Minor Bleeding during Treatment with Low-Molecular-Weight Heparin or Unfractionated Heparin

Outcome	Low-Molecular-Weight Heparin Recipients	Unfractionated Heparin Recipients	Odds Ratio (95% CI)
	<i>n/n (%)</i>		
Major bleeding	14/1023 (1.4)	21/928 (2.3)	0.67 (0.36–1.27)*
Minor bleeding	67/982 (6.8)†	48/874 (5.5)†	1.08 (0.73–1.59)‡

* Heterogeneity: chi-square = 5.03.

† Data on this outcome were not available from the study by Decousus et al. (41).

‡ Heterogeneity: chi-square = 12.78.



Ann Intern Med. 2004;140:175-183.

Lytics in high risk PE

Thrombolytic regimens, doses, and contraindications

Molecule	Regimen	Contraindications to fibrinolysis
rtPA	100 mg over 2 h	Absolute History of haemorrhagic stroke or stroke of unknown origin Ischaemic stroke in previous 6 months Central nervous system neoplasm Major trauma, surgery, or head injury in previous 3 weeks Bleeding diathesis Active bleeding Relative Transient Ischaemic attack in previous 6 months Oral anticoagulation Pregnancy or first post-partum week Non-compressible puncture sites Traumatic resuscitation Refractory hypertension (systolic BP >180 mmHg) Advanced liver disease Infective endocarditis Active peptic ulcer
	0.6 mg/kg over 15 min (maximum dose 50 mg) ^a	
Streptokinase	250 000 IU as a loading dose over 30 min, followed by 100 000 IU/h over 12–24 h	
	Accelerated regimen: 1.5 million IU over 2 h	
Urokinase	4400 IU/kg as a loading dose over 10 min, followed by 4400 IU/kg/h over 12–24 h	
	Accelerated regimen: 3 million IU over 2 h	



Table 3. Postoperative Outcomes

Outcome	Overall (N = 1,075)	No Shock (n = 719)	Shock-No CPR (n = 203)	Shock-CPR (n = 153)	p Value
Operative mortality	171 (15.9)	57 (7.9)	46 (23.7)	68 (44.4)	<0.0001
Major morbidity	532 (49.5)	297 (41.3)	133 (65.5)	102 (66.7)	<0.0001
Renal failure	78 (7.8)	36 (5.3)	22 (12.4)	20 (14.7)	<0.0001
New dialysis	72 (6.9)	29 (4.1)	23 (11.9)	20 (13.4)	<0.0001
Prolonged ventilation	478 (44.5)	257 (35.7)	123 (60.6)	98 (64.1)	<0.0001
Deep sternal wound infection	7 (0.7)	0 (0.0)	6 (3.0)	1 (0.7)	<0.0001
Reoperation	216 (20.0)	121 (16.8)	60 (29.6)	35 (22.9)	0.0002
Permanent stroke	23 (2.1)	9 (1.3)	7 (3.5)	7 (4.6)	0.0126

sion is made, regardless of the results.

In the case of pulmonary embolectomy, this is exactly what happened. If patients survived the surgery, critics declared that the operation was unnecessary. And the harshest critics were cardiac surgeons. They berated their usually junior colleagues for operating on these patients, because patients who survived were supposedly not sufficiently ill to warrant surgery. On the other hand, if patients died postoperatively, the operation itself was declared futile, and the surgeon who operated was chastised for wasting resources, for being impulsive, and for not knowing when to say “no.” When such cases were reviewed at morbidity and mortality conferences, senior cardiac surgeons would often impose an informal moratorium on pulmonary embolectomy.



ECMO?

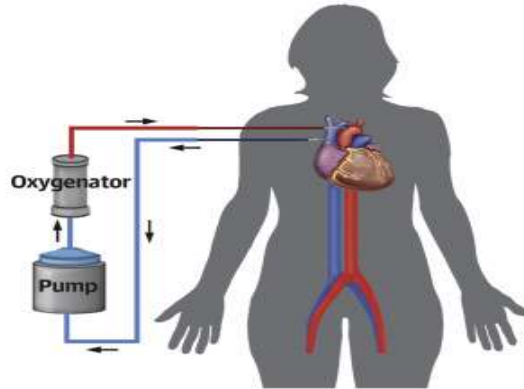
ECMO and/or Surgical Embolectomy

Benefits

- Rapidly optimize BP, RV
- Maximize clot removal
- 2%: Mortality in non-CPR patients

Risks

- 18%: Ventilator >72 hours
- 18%: Hemodialysis required
- 25%: Mortality in CPR patients

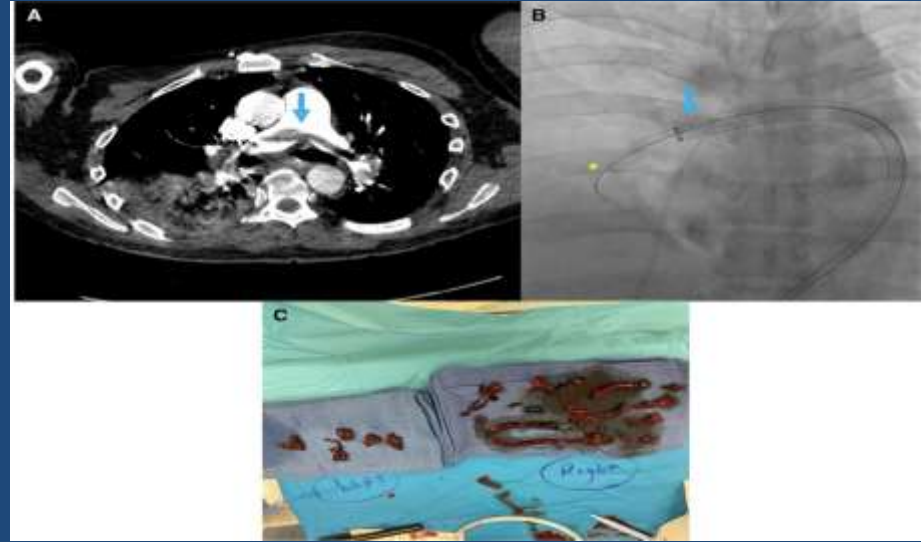


ECMO



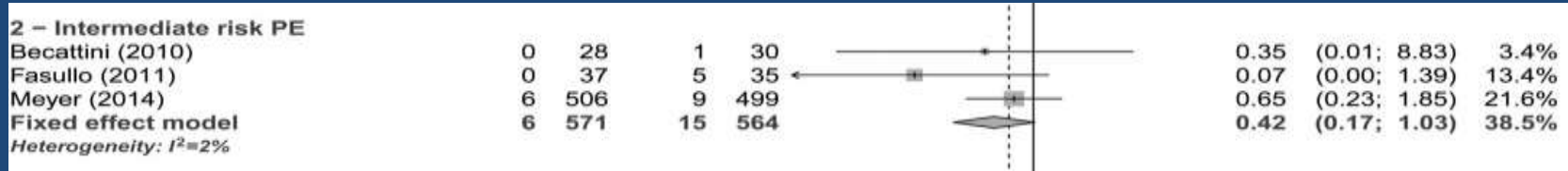
Embolectomy

Percutaneous therapy

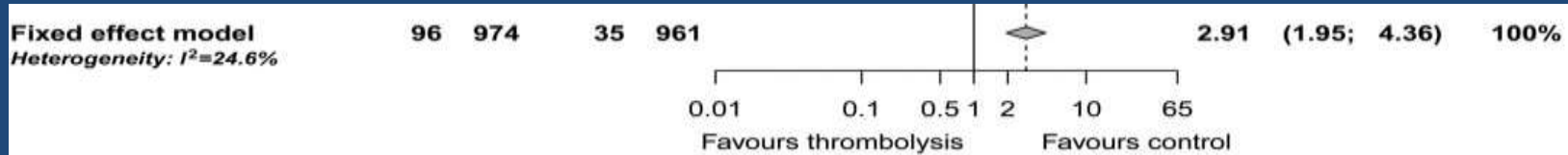


- Improvement in imaging endpoints, ie RV dysfunction
- Generally safe, low AER
- Clinical outcomes lacking

Lytic in intermediate risk?



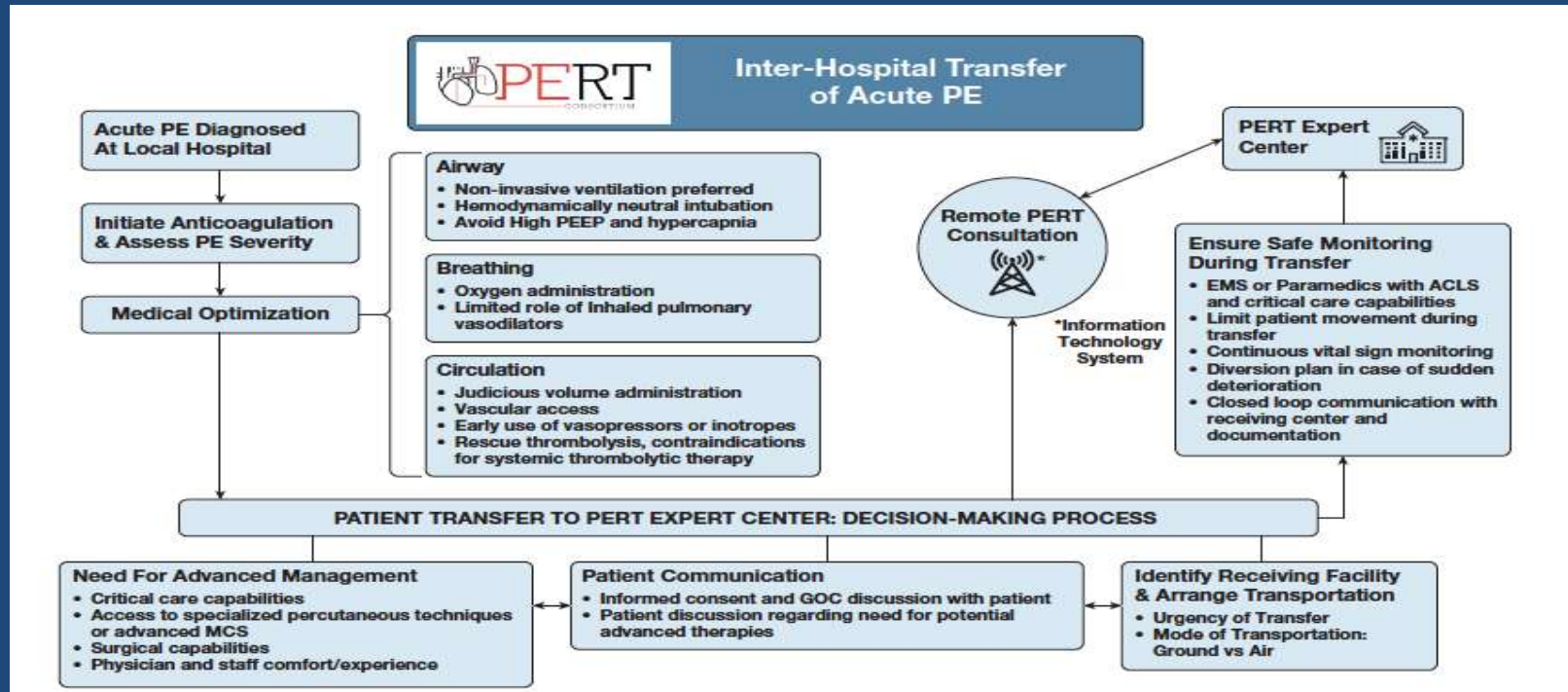
NNT = 62; PSR = 98.4%



NNH = 16; PSR = 93.8%

For every life saved with lytic, cause 4 excess major bleeds

Inter-hospital transfer & PERT team



Other considerations

- Age appropriate cancer screening
- NOAC preferred over VKA if eligible
- Filter rarely, only if AC absolutely contraindicated
- Consider long term AC if unprovoked or recurrent PE
- Consider CTEPH and PTS in the chronic phase





Post-op course

- IVC filter placed to protect the RV
- Kidney failure requiring renal replacement
- Persistent respiratory failure requiring tracheostomy
- Persistent shock requiring vasopressors
- Pneumonia and empyema requiring antibiotics
- Discharged to rehab after 5 weeks
- Full functional recovery



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