Pulmonary Embolism
Risk Stratification & Eligible Patients

INARI MEDICAL®

Traditional risk stratification weighs mortality vs. thrombolytic bleeding risk, ignoring other predictors of adverse events

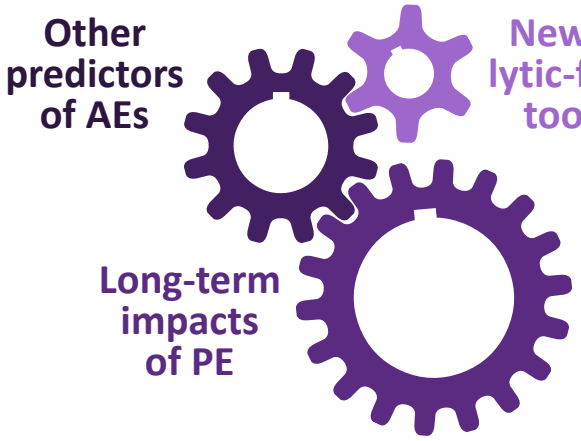
Anticoagulation Only

All-cause mortality at 30 days[1-4]

6% - 15% in Submassive patients

25% - 50% in Massive patients

Typically Overlooked

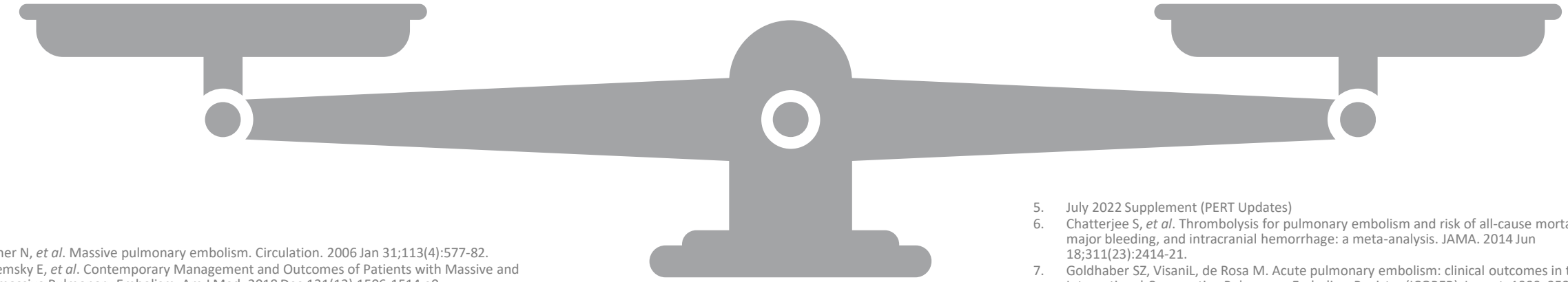


Thrombolytics

Major Bleeding

9% - 22% major bleeding[6,7]

1.5% - 3% intracranial hemorrhage (ICH)[6,8]



1. Kucher N, *et al*. Massive pulmonary embolism. Circulation. 2006 Jan 31;113(4):577-82.
2. Secemsky E, *et al*. Contemporary Management and Outcomes of Patients with Massive and Submassive Pulmonary Embolism. Am J Med. 2018 Dec;131(12):1506-1514.e0
3. Schultz J, *et al*. A Multidisciplinary Pulmonary Embolism Response Team (PERT) - Experience from a national multicenter consortium. Pulm Circ. 2019 Jan 11;9(3):2045894018824563
4. PERT Consortium Quality Database. October 2021 (Presented by Secemsky E)
5. July 2022 Supplement (PERT Updates)
6. Chatterjee S, *et al*. Thrombolysis for pulmonary embolism and risk of all-cause mortality, major bleeding, and intracranial hemorrhage: a meta-analysis. JAMA. 2014 Jun 18;311(23):2414-21.
7. Goldhaber SZ, VisaniL, de Rosa M. Acute pulmonary embolism: clinical outcomes in the International Cooperative Pulmonary Embolism Registry (ICOPER). Lancet. 1999; 353:1386-9.
8. Budaj-Fidecka A, Kurzyna M, Fijalkowska A *et al*. In-hospital major bleeding predicts mortality in patients with pulmonary embolism: an analysis of ZATPOL registry data. Int J Cardiol. 2013; 168:3543-9.

Risk stratification for acute PE as part of the ESC guidelines

Risk of early death		Indicators of risk			
		Haemodynamic instability	Clinical parameters of PE severity and/or comorbidity[a]	Right ventricular dysfunction[b]	Elevated plasma levels of cardiac troponins
High		+	+	+	+
Intermediate	Intermediate–high	–	+	+	+
	Intermediate–low	–	+	One (or none) positive	
Low		–	–	–	– (if assessed[c])

Classification according to the 2019 ESC guidelines for the diagnosis and management of acute pulmonary embolism (PE)[30]. [a]PE Severity Index (PESI) class III–V or simplified PESI ≥1. [b]Measured using transthoracic echocardiography or computed tomography pulmonary angiography. [c]Assessment optional.

Götzinger F, Lauder L, Sharp ASP, Lang IM, Rosenkranz S, Konstantinides S, Edelman ER, Böhm M, Jaber W, Mahfoud F. Interventional therapies for pulmonary embolism. Nat Rev Cardiol. 2023 May 12:1–15. doi: 10.1038/s41569-023-00876-0. Epub ahead of print. PMID: 37173409; PMCID: PMC10180624.

ESC guidelines from 2019 recommends catheter-directed treatment in certain patient groups

High-risk PE

Percutaneous catheter-directed treatment should be considered for patients with high-risk PE, in whom thrombolysis is ***contraindicated*** *or* ***has failed***.

Intermediate-high risk PE

As an alternative to rescue thrombolytic therapy, surgical embolectomy or percutaneous catheter-directed treatment should be considered for patients with ***hemodynamic deterioration on anticoagulation treatment***.

Götzinger F, Lauder L, Sharp ASP, Lang IM, Rosenkranz S, Konstantinides S, Edelman ER, Böhm M, Jaber W, Mahfoud F. Interventional therapies for pulmonary embolism. Nat Rev Cardiol. 2023 May 12:1–15. doi: 10.1038/s41569-023-00876-0. Epub ahead of print. PMID: 37173409; PMCID: PMC10180624.

The clinical consensus statement specifies treatment failure as failure with deterioration and failure with lack of improvement

GOAL: describe the currently available CDT approaches in PE patients and standardise patient selection, the **timing** and technique of the procedure itself

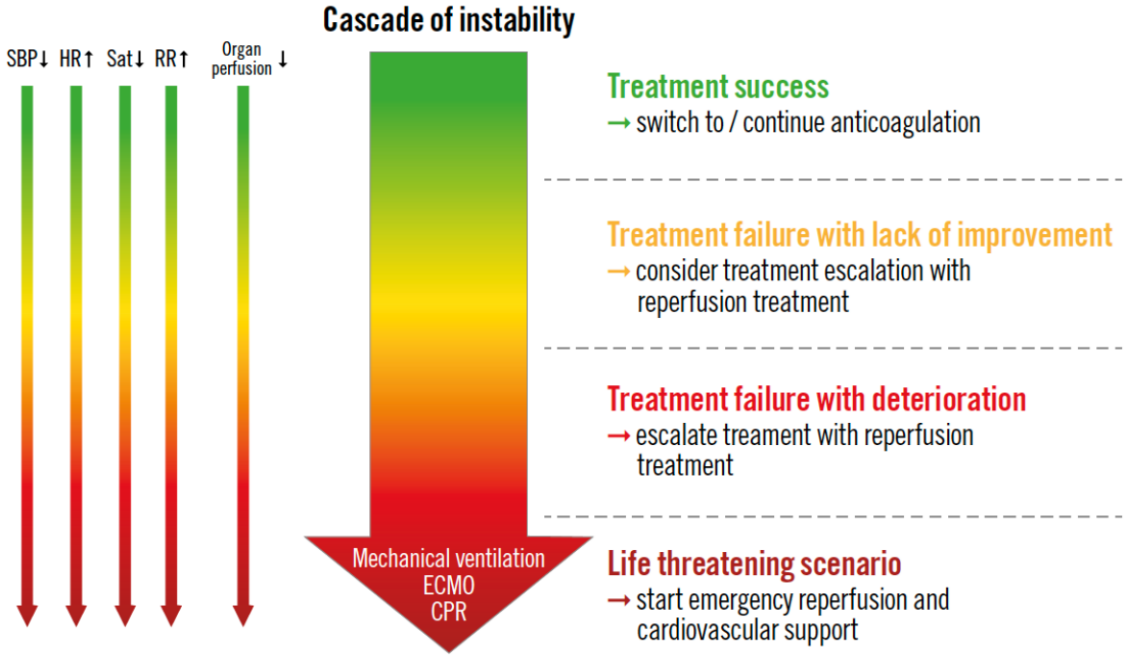


Figure 1. Treatment efficacy of acute pulmonary embolism. CPR: cardiopulmonary resuscitation; ECMO: extracorporeal membrane oxygenation; HR: heart rate; RR: respiratory rate; Sat: saturation; SBP: systolic blood pressure

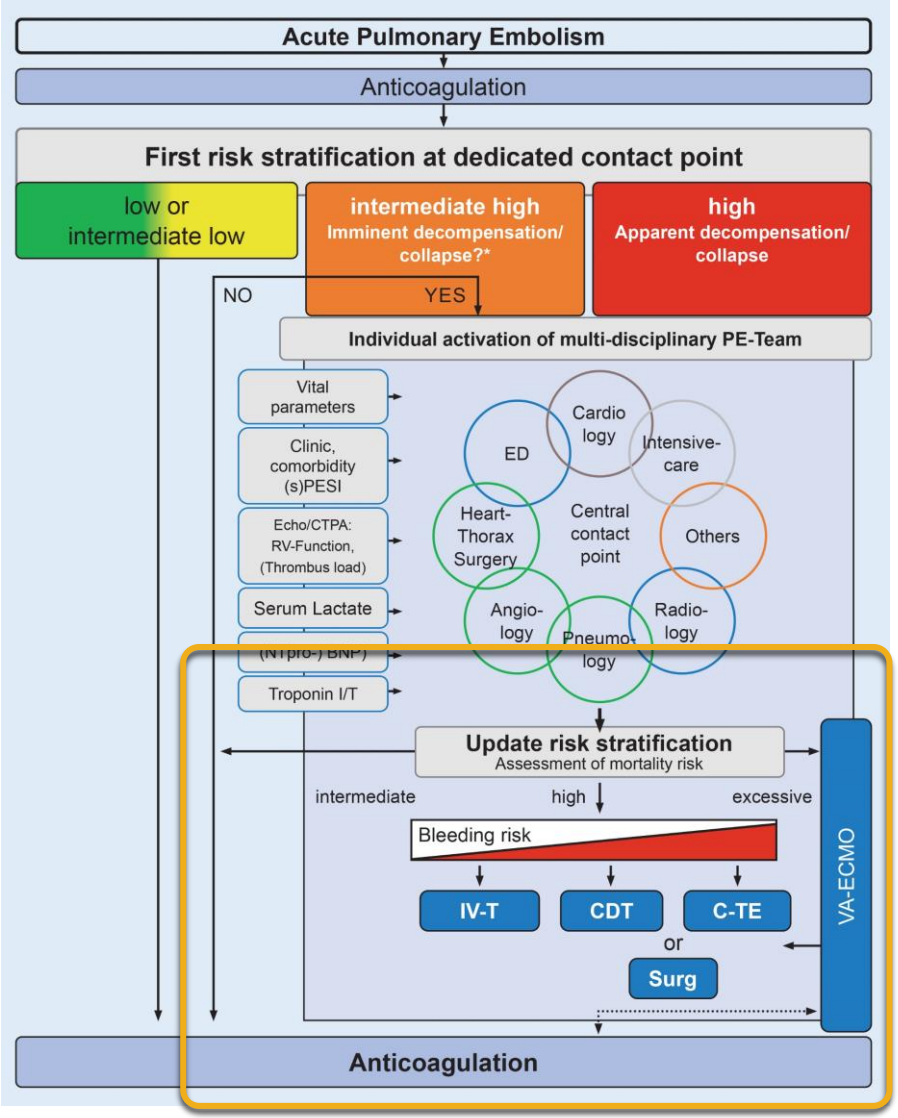
Risk Group	Time window to treatment escalation	
High-risk PE	No hemodynamic improvement is achieved 2-4 hours after the completion of full-dose thrombolysis	No hemodynamic improvement is achieved immediately after the completion of the local thrombolysis infusion
Intermediate-High-risk PE	Compromised vital signs are not alleviated after 24-48 hours of therapeutic-dose anticoagulation	

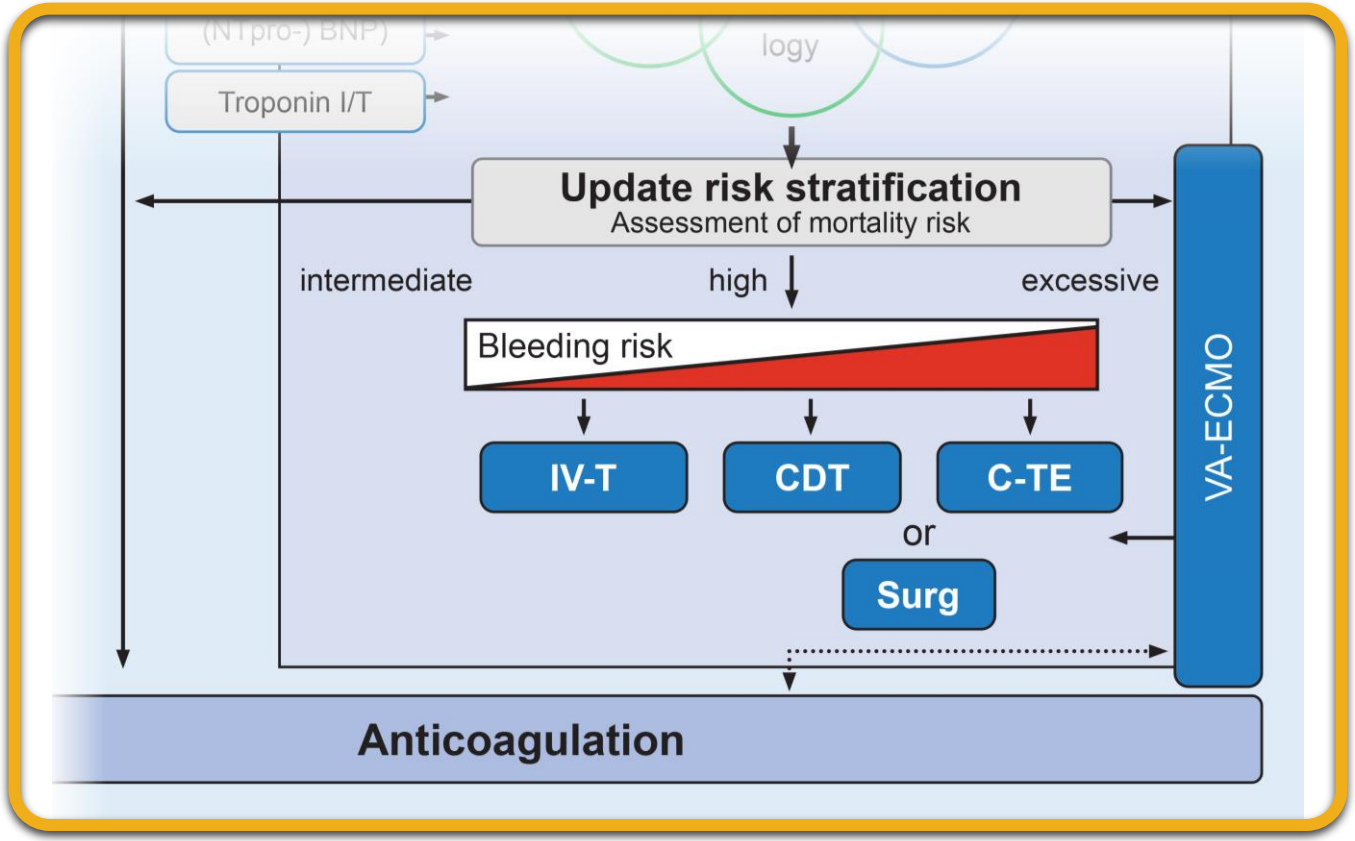
Lack of improvement

The consensus paper now defines **treatment failure** also **due to lack of improvement**, after specific time windows

1. EuroIntervention 2022;18:e623-e638. DOI: 10.4244/EIJ-D-22-00246

The German DGK consensus paper takes the bleeding risk into the decision and recommends thrombectomy in case of a high bleeding risk

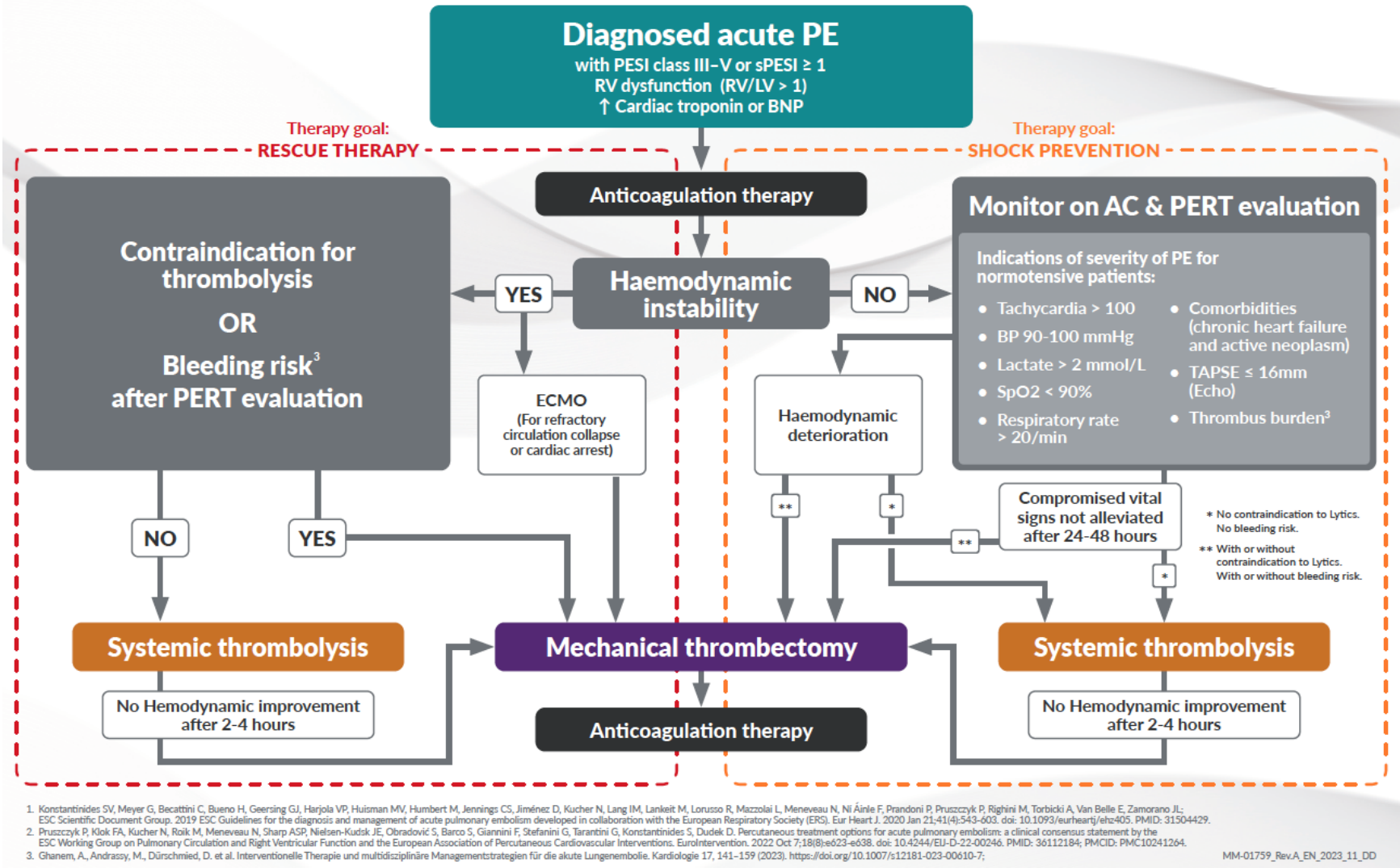




IV-T: intra venous/systemic thrombolysis
CDT: catheter directed thrombolysis
C-TE: catheter based thrombectomy (INARI)

Ghanem, A., Andrassy, M., Dürschmied, D. *et al*. Interventionelle Therapie und multidisziplinäre Managementstrategien für die akute Lungenembolie. Kardiologie 17, 141–159 (2023). https://doi.org/10.1007/s12181-023-00610-7

Use of Mechanical Thrombectomy based on the ESC Guidelines 2019[1], ESC Consensus Statement 2022[2] and DGK consensus statement 2023[3]



1. Konstantinides SV, Meyer G, Becattini C, Bueno H, Geersing GJ, Harjola VP, Huisman MV, Humbert M, Jennings CS, Jiménez D, Kucher N, Lang IM, Lankeit M, Lorusso R, Mazzolai L, Meneveau N, Ní Áinle F, Prandoni P, Pruszczyk P, Righini M, Torbicki A, Van Belle E, Zamorano JL; ESC Scientific Document Group. 2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the European Respiratory Society (ERS). Eur Heart J. 2020 Jan 21;41(4):543-603. doi: 10.1093/eurheartj/ehz405. PMID: 31504429.
2. Pruszczyk P, Klok FA, Kucher N, Roik M, Meneveau N, Sharp ASP, Nielsen-Kudsk JE, Obradović S, Barco S, Giannini F, Stefanini G, Tarantini G, Konstantinides S, Dudek D. Percutaneous treatment options for acute pulmonary embolism: a clinical consensus statement by the ESC Working Group on Pulmonary Circulation and Right Ventricular Function and the European Association of Percutaneous Cardiovascular Interventions. EuroIntervention. 2022 Oct 7;18(8):e623-e638. doi: 10.4244/EIJ-D-22-00246. PMID: 36112184; PMCID: PMC10241264.
3. Ghanem, A., Andrassy, M., Dürschmied, D. et al. Interventionelle Therapie und multidisziplinäre Managementstrategien für die akute Lungenembolie. Kardiologie 17, 141–159 (2023). https://doi.org/10.1007/s12181-023-00610-7;

MM-01759_Rev.A_EN_2023_11_DD

Is the risk stratification within the current guidelines able to define all patients with a high mortality risk?

Stages of Cardiogenic Shock in PE

	Low Risk	Submassive (Intermediate Risk)		Massive (High Risk)	
	At Risk for Shock	Normotensive Shock	Hypotension req support	Progressive Shock	Cardiac Arrest
Dilated RV	• Normotensive • Large clot burden • Residual DVT • Clot in transit	• Normotensive • tachy, SI>1 • EKG changes • +lactate • Cold/clammy/ oliguric	• Hypotensive • Single pressor	• Escalating pressors • Intubated • Rising Cr/LFTs, lactate	• CPR

Slide as presented by Dr Catalin Toma at MADRID ACCIS – 2023 congress (Acute Cardiac Care, Interventions & Support) on June 16th 2023: 'Data and lessons from the FLASH project. Is the paradigm of severe PE management changing?'

Are we able to exactly define the bleeding risk of our patients?

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 postpartum week
- Non-compressible puncture sites
- Traumatic resuscitation
- Use of ECMO
- Advanced liver disease
- Infective endocarditis
- Active peptic ulcer
- Refractory hypertension (systolic BP >180 mmHg)

Different sources seem to have different opinions on contraindications to thrombolytics

Society Contraindication Recommendations

Contraindication	Reference	American College of Chest Physicians	AHA	ESC	SIR 2014	CHEST 2016
	Societal Source	a	b	c	d	e
Central nervous system damage or neoplasm or seizure disorder				Absolute	Relative	
Previous ICH		Major	Major	Absolute	Absolute	Major
Structural Intracranial disease		Major	Major			Major
Ischemic stroke within 3-6 months		Major	Major	Absolute	Absolute	Major
Active bleeding		Major	Major	Absolute	Absolute	Major
GI bleeding within 3 mo					Relative	
Bleeding diathesis		Major	Major	Absolute		Major
Recent brain/spinal injury		Major	Major	Absolute	Absolute	Major
Absolute Contraindication to AC					Absolute	
Suspected aortic dissection						
Recent head trauma with fracture or brain injury		Major	Major	Absolute	Absolute	Major
Age >75 y		Relative	Relative			Relative
AC therapy		Relative	Relative	Relative		Relative
Noncompressible vascular punctures			Relative	Relative		
Pregnancy/Recent delivery/lactation		Relative	Relative	Relative	Relative	Relative
Recent invasive procedure/major surgery		Relative	Relative	Absolute	Relative	Relative
Traumatic/Prolonged CPR		Relative	Relative	Relative	Relative	Relative
Recent internal bleeding			Relative			
Recent non-ICH bleeding		Relative	Relative			Relative
Pericarditis or pericardial fluid		Relative	Relative			Relative
Systolic BP >180 or Diastolic BP >110		Relative	Relative	Relative	Relative	Relative
Weight <60kg		Relative	Relative			Relative
Ischemic stroke or transient ischemic attack > 3-6 mo ago		Relative	Relative	Relative		Relative
Diabetic retinopathy		Relative	Relative		Relative	Relative
Female		Relative	Relative			Relative
Black race		Relative	Relative			Relative
Dementia						
Active peptic ulcer disease				Relative		
Infective endocarditis				Relative	Relative	
Advanced liver disease				Relative	Relative	
Organ biopsy					Relative	
Cataract or other eye surgery					Relative	
Severe allergic reaction to lytics, AC, or contrast					Relative	
Known right-to-left cardiac or pulmonary shunt or left heart thrombus					Relative	
Severe dyspnea					Relative	
Acute medical illness precluding safe procedure performance					Relative	
Suspicion of infected venous thrombus					Relative	
Renal failure (eGFR <60 mL/min)					Relative	
Severe thrombocytopenia					Relative	

a. CHEST ACCP 2012 Supplement - Kearon *et al.* Table 11
b. AHA 2019 Scientific Statement - Giri *et al.* Table 2
c. AHA 2011 Scientific Statement - Jaff *et al.* pages 1795-1797
d. ESC 2019 Guidelines - Konstantinides *et al.* Table 10
e. SIR 2014 Quality Improvement Guidelines - Vedantham *et al.* Table 1
f. CHEST 2016 Guideline - Kearon *et al.* Table 15

Study Exclusions

Study Source	PEITHO	HI-PEITHO	SEATTLE-II	Optalyse	SUNSET-sPE	ULTIMA	PEITHO-3
Haemodynamic collapse at presenation (CPR, ECMO, PE shock, persistent hypotension, sepsis)	x	x	x	x		x	
Known significant bleeding risk	x				x	x	x
Recent admin of thrombolytic agents	x	x	x	x		x	x
Recent IVC filter or thrombectomy	x			x			x
Uncontrolled HTN	x					x	
Known hypersensitivity to tPA/AC	x	x		x		x	x
Pregnancy/lactation/recent labor	x	x	x	x	x	x	x
Known coagulation disorder	x						
Any condition that would put pt at increased risk	x		x	x		x	x
ICU admission for non-PE reason		x					
High fever		x					
History of ICH		x	x	x	x		x
History of intraocular bleeding/eye surgery/hemorrhagic retinopathy		x				x	
History of stroke or TIA		x	x	x	x		x
CNS or metastatic cancer		x		x	x		x
Major surgery or trauma		x	x	x	x	x	x
Low platelets/hematocrit		x	x			x	x
Recent LMWH, DOAC, VKA, or antiplatelet admin/INR >1.5-3/aPTT >50 sec		x	x	x		x	x
Short life expectancy 1-12 mo		x	x	x	x	x	x
Recent major bleed/GI bleed			x	x		x	
Renal failure			x	x		x	
history of HIT				x			
Active bleeding					x	x	x
Suspected aortic dissection					x		
Arterior venous malformation						x	
Aneurysm						x	
Large >10mm right atrial or RV thrombus						x	
Hemodynamic instability							x
Recent vascular surgery							x
INR >1.4							x
Severe hepatic disease, portal hypertension, or active hepatitis							x
Recent peptic ulcer							x
Women of childbearing potential without negative pregnancy test and do not use an effective method of birth control							x

PEITHO : https://classic.clinicaltrials.gov/ct2/show/NCT00639743
HI PEITHO : https://clinicaltrials.gov/study/NCT04790370
SEATLE II : https://www.clinicaltrials.gov/study/NCT01513759
OPTALYSE : https://clinicaltrials.gov/study/NCT02396758
SUNSET sPE : https://classic.clinicaltrials.gov/ct2/show/NCT02758574
ULTIMA : https://clinicaltrials.gov/study/NCT01166997
PEITHO 3 : https://clinicaltrials.gov/study/NCT04430569

IFU of Lytics

Lytic	Alteplase	Tenecteplase	Urokinase
Current ICH	Contraindication		
Subarachnoid hemorrhage	Contraindication		
Active internal bleeding	Contraindication	Contraindication	Contraindication
Recent intracranial or intraspinal surgery	Contraindication	Contraindication	Contraindication
Recent serious head trauma	Contraindication	Contraindication	Contraindication
Intracranial conditions that increase risk of bleeding like neopalsms, AV malformations or aneurysms	Contraindication	Contraindication	Contraindication
Bleeding diathesis	Contraindication	Contraindication	Contraindication
Uncontrolled hypertension	Contraindication	Contraindication	Contraindication
History of recent stroke	Contraindication		
Avoid intramuscular injections and trauma	Warning/Precaution	Warning/Precaution	Warning/Precaution
Avoid IJ and subclavian venous punctures	Warning/precaution	Warning/Precaution	
Concomitant use of aspirin and heparin	Warning/Precaution		
Major surgery	Warning/Precaution		Warning/Precaution
Cerebrovascular disease	Warning/Precaution		Warning/Precaution
Recent ICH	Warning/Precaution		
Recent GI bleed	Warning/Precaution		Warning/Precaution
Hypertension	Warning/Precaution		
Acute pericarditis	Warning/Precaution		
Subacute bacterial endocarditis	Warning/Precaution		Warning/Precaution
Hemostatic defects	Warning/Precaution		Warning/Precaution
Significant hepatic dsyfunction	Warning/Precaution		Warning/Precaution
Pregnancy	Warning/Precaution		Warning/Precaution
Diabetic hemorrhagic retinopathy	Warning/Precaution		Warning/Precaution
Other hemorrhagic opthatlmic conditions	Warning/Precaution		
Septic thrombophlebitis	Warning/Precaution		
Advanced age	Warning/Precaution		
Currently receiving anticoagulation	Warning/Precaution		
Known hypersensitivity to ingredients	Warning/Precaution	Potential AE	Warning/Precaution
ICH		Potential AE	
Fatal bleeding		Potential AE	
Recent Trauma			Contraindication
Recent CPR			Contraindication
Concomitant use of thrombolytic agents, AC, or antiplatelets			Warning/Precaution
Extra attention to all potential bleeding sites (including catheter insertion sites, arterial and venous puncture sites, cutdown sites, and other needle puncture sites)			Warning/Precaution
Patient handling			Warning/Precaution
Venipunctures and arterial punctures			Warning/Precaution
Obstetrical delivery			Warning/Precaution
Organ biopsy			Warning/Precaution
Previous puncture of noncompressible wounds			Warning/Precaution
Other condition in which bleeding might constitute a significant hazard or be particularly difficult to manage because of its location			Warning/Precaution
Myocardial infarction			Potential AE
Recurrent PE			Potential AE
Hemiplegia			Potential AE
Stroke			Potential AE
Decreased hematocrit			Potential AE
Substernal pain			Potential AE
Thrombocytopenia			Potential AE
Diaphoresis			Potential AE
Allergtic reaction			Potential AE
Infusion reaction (including hypoxia, cyanosis, dyspnea, tachycardia, hypotension, hypertension, acidosis, fever, chills, rigors, back pain, vomiting, and nausea)			Potential AE

RV/LV ratio is an independent predictor of death and hemodynamic collapse

ESC Guidelines recommend RV/LV ratio measured for all acute PE patients (2019)[5]

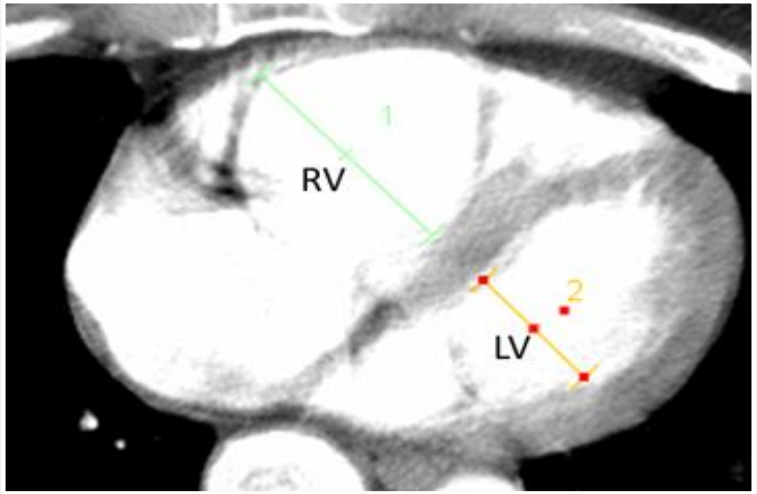


Image: FLARE IDE Study: (Tu *et al*. 2019)

Variables	OR (95% CI)	*P*
Age	1.01 (0.98-1.04)	0.453
TTE RV strain	—	—
CT RV/LV (0.1 increment)	1.14 (1.02-1.27)	0.023
IVC filter	1.06 (0.44-2.55)	0.888
Anticoagulation	0.19 (0.07-0.54)	0.002
Coronary artery disease	1.69 (0.68-4.22)	0.259
CHF	4.09 (1.33-12.6)	0.014
Malignancy	5.79 (2.40-14.0)	< 0.001

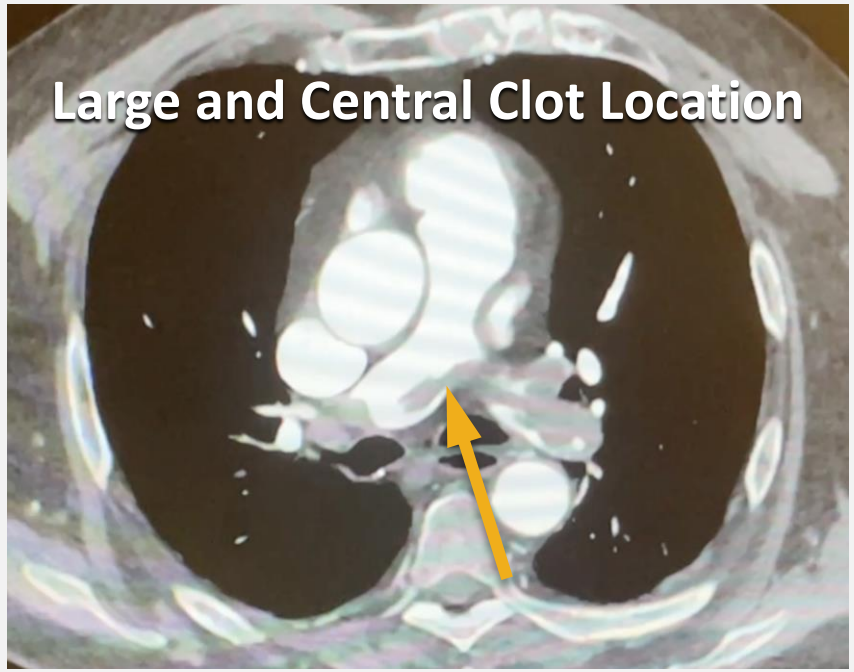
≥0.9 Independent predictor of death, hemodynamic collapse[1,2,3].

+0.1 For every 0.1 increase in RV/LV ratio, the odds ratio for death is 1.14[4]

1. Becattini *et al*. Multidetector computed tomography for acute pulmonary embolism: diagnosis and risk stratification in a single test. European Heart Journal (2011)
2. Schoepf *et al*. Right ventricular enlargement on chest computed tomography: a predictor of early death in acute pulmonary embolism. Circulation. 2004
3. George *et al*. A retrospective analysis of catheter-based thrombolytic therapy for acute submassive and massive pulmonary embolism. Vascular Medicine. 2015, Vol. 20(2) 122–130
4. George *et al*. Computed tomography and echocardiography in patients with acute pulmonary embolism part 2:prognostic value. J Thorac Imaging 2014;29:W7-W12
5. Konstantindes *et al*. 2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the European Respiratory Society (ERS)

Large & central clot burden are significant predictors of adverse events and easily assessed on CT

Clot size and location are **not** included in any traditional risk stratification tool



Large Clot Burden[1]

>17X

Risk of 6-month all-cause mortality

*+ 2.4X risk of AEs**

Systemic review & meta-analysis, N=260

Central Clot[2]

>2X

Risk of PE-related mortality

10-year Registry (2004-2013)
Average 34-month follow-up, N=530

1. Meinell *et al*. Predictive value of computed tomography in acute pulmonary embolism: Systematic review and meta-analysis. Am J Med. 2015;128:747–59.e2.
2. Martinez *et al*. 2016. Central Venous Peripheral Pulmonary Embolism: Analysis of the Impact on the Physiological Parameters and Long-Term Survival. N AM J Med Sci. 2016

* Adverse events include death, Pulmonary Hypertension, Intensive Care Treatment.

Concomitant DVT is common and increases the mortality risk

Diagnosing DVT during PE treatment may reduce PE-related mortality, and prompt timely prevention of post-thrombotic syndrome (PTS) symptoms.[1]

50-65%

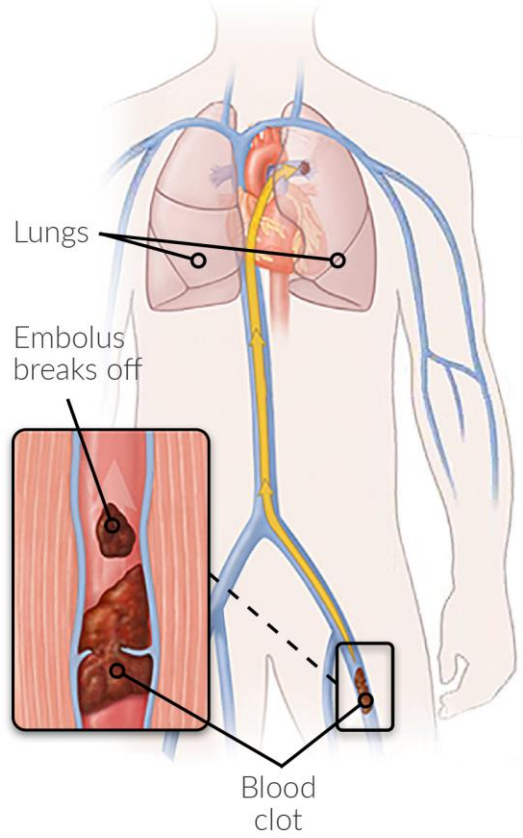
Of patients with PE also have **proximal DVT**[1-3]

>4X

Risk of **90-day PE-related mortality** in PE patients with proximal DVT[4]

>4X

Risk of 90-day **recurrent VTE** in PE patients with proximal DVT[4]



1. Hirmerova, *et al*. The Prevalence of Concomitant Deep Vein Thrombosis, Symptomatic or Asymptomatic, Proximal or Distal, in Patients With Symptomatic Pulmonary Embolism. Clin Appl Thromb Hemost. 2018 Nov.
2. Becattini, *et al*. Risk Stratification of Patients With Acute Symptomatic Pulmonary Embolism Based on Presence or Absence of Lower Extremity DVT: Systematic Review and Meta-analysis. Chest. 2016 Jan.
3. Nishiwaki, *et al*. Impact of Concomitant Deep Vein Thrombosis on Clinical Outcomes in Patients With Acute Pulmonary Embolism. American Heart Association. 2019 Nov.
4. Jiménez, *et al*. Prognostic significance of deep vein thrombosis in patients presenting with acute symptomatic pulmonary embolism. Am J Respir Crit Care Med. 2010 May

Normotensive PE patients are often sicker than they appear

"Our current definition and risk stratification tools may not be sufficient to identify these [patients at risk of hemodynamic decompensation] with Submassive PE."[2]

Porcaro, et al[1]; Khandhar, *et al*.[2]

~40%

of normotensive PE patients are in **cardiogenic shock** (low CI)*

FLASH Registry Analysis[3]

~20%

of PE patients with sPESI=0 are in **cardiogenic shock****

* Low CI defined as <1.8 L/min/m^2

** Low CI defined as <2.0 L/min/m^2

1. Porcaro *et al*. Submassive Pulmonary Embolism: Are We Falsely Reassured by Normotension? ACC 2019. Poster Session Abstract, Presentation number:1007-15
2. Khandhar *et al*. Invasive hemodynamic assessment of patients with submassive pulmonary embolism. Catheter Cardiovasc Interv. 2019;1–6.
3. FLASH Registry results. Presented at SCCM 2022.

Heart rate predicts mortality in acute symptomatic PE

[Pulmonary and Cardiovascular Original Research]

CHEST

Heart Rate and Mortality in Patients With Acute Symptomatic Pulmonary Embolism

*Ana Jaureguízar, MD; David Jiménez, MD, PhD; Behnood Bikdeli, MD; Pedro Ruiz-Artacho; Alfonso Muriel, PhD; Victor Tapson, MD; Raquel López-Reyes, MD, PhD; Beatriz Valero, MD; Gili Kenet, MD; Manuel Monreal, MD, PhD; and the Registro Informatizado de la Enfermedad TromboEmbólica Investigators**

INTERPRETATION: In nonhypotensive patients with acute symptomatic PE, a high HR portends an increased risk of all-cause and PE-related mortality. Modifying the HR cutoff in the sPESI and the Bova score improves prognostication of patients with PE.

CHEST 2021; ■(■):■-■

CHEST. 2022 Feb;161(2):524-534.

Venous Lactate improves the prediction of adverse outcomes in normotensive PE

Ann Emerg Med. 2013 Mar;61(3):330-8. doi: 10.1016/j.annemergmed.2012.10.022. Epub 2013 Jan 7.

Prognostic value of plasma lactate levels among patients with acute pulmonary embolism: the thrombo-embolism lactate outcome study

Simone Vanni [1], Gabriele Viviani, Michele Baioni, Giuseppe Pepe, Peiman Nazerian, Filippo Socci, Maurizio Bartolucci, Marco Bartolini, Stefano Grifoni

Results: Of the 270 patients included in the study, the mean age was 73 years (SD 12.7 years) and 151 (55.9%) were women. Twelve patients (4.4%) showed shock or hypotension (shock or systolic arterial pressure <100 mm Hg) at presentation, 109 (40.4%) had right-sided ventricular dysfunction, 93 (34.4%) showed troponin I level greater than or equal to 0.10 ng/mL, and 81 (30%) showed lactate level greater than or equal to 2 mmol/L. Seventeen patients (6.3%) died, 12 (4.4%) because of pulmonary embolism, and 37 (13.7%) reached the composite endpoint. Patients with lactate level greater than or equal to 2 mmol/L showed higher mortality (17.3%; 95% confidence interval [CI] 11.9% to 20%) than patients with a lower level (1.6%; 95% CI 0.8% to 1.9%). Plasma lactate level was associated with all-cause death (hazard ratio 11.67; 95% CI 3.32 to 41.03) and the composite endpoint (hazard ratio 8.14; 95% CI 3.83 to 17.34) independent of shock or hypotension, right-sided ventricular dysfunction, or elevation of troponin I values.

ELSEVIER

European Journal of Internal Medicine

journal homepage: www.elsevier.com/locate/ejim

Original article

Venous lactate improves the prediction of in-hospital adverse outcomes in normotensive pulmonary embolism

Matthias Ebner [a,b], Charlotta F. Pagel [c], Carmen Sentler [c], Veli-Pekka Harjola [d], Héctor Bueno [e,f,g], Markus H. Lerchbaumer [h], Karl Stangl [a], Burkert Pieske [b,i,j], Gerd Hasenfuß [c,k], Stavros V. Konstantinides [l,m], Mareike Lankeit [b,c,i,l,*]

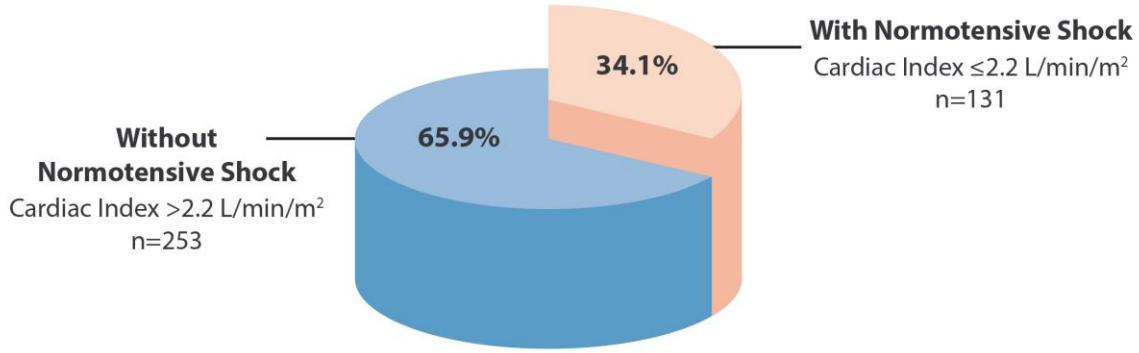
Results: An optimised venous lactate cut-off value of 3.3 mmol/l predicted both, in-hospital adverse outcome (OR 11.0 [95% CI 4.6–26.3]) and all-cause mortality (OR 3.8 [95%CI 1.3–11.3]). The established cut-off value for

Conclusion: Venous lactate above the upper limit of normal was associated with increased risk for adverse outcomes and an optimised cut-off value of 3.3 mmol/l predicted adverse outcome and mortality. Adding venous lactate to the 2019 ESC algorithm may improve risk stratification. Importantly, the established cut-off value for arterial lactate has limited specificity in venous samples and should not be used.

Vanni, *et al*. Ann Emerg Med. 2013 Mar;61(3):330-8.

A new composite shock score helps to predict normotensive shock in Intermediate-risk pulmonary embolism

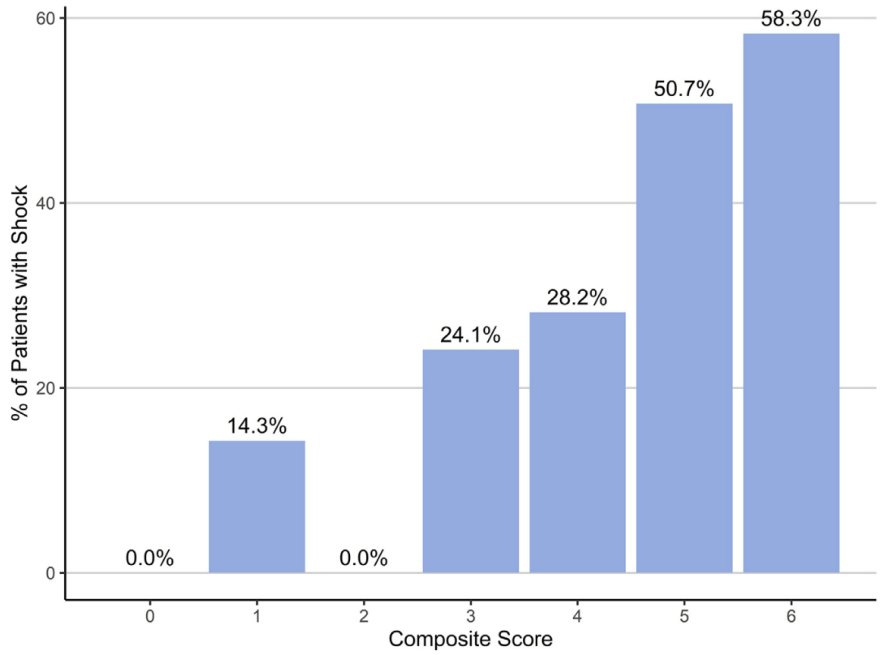
Normotensive Shock in Patients With Intermediate-Risk Pulmonary Embolism From the FLASH Registry



Composite Shock Score

Elevated Troponin + Elevated BNP + Moderate/Severely Reduced RV function + Saddle PE + Concomitant DVT + Tachycardia

Risk Factor Associated With Normotensive Shock
(OR: 5.84; 95% CI: 2.00-17.04)



A composite shock score consisting of 1 point each for elevated troponin, elevated B-type natriuretic peptide, concomitant deep vein thrombosis, saddle pulmonary embolism, moderately or severely reduced right ventricular function, and tachycardia was calculated for each patient who had data available for all 6 components. **Bars** represent the proportion of patients with shock out of all patients who had a given score.

Bangalore S, Horowitz JM, Beam D, Jaber WA, Khandhar S, Toma C, Weinberg MD, Mina B. Prevalence and Predictors of Cardiogenic Shock in Intermediate-Risk Pulmonary Embolism: Insights From the FLASH Registry. JACC Cardiovasc Interv. 2023 Apr 24;16(8):958-972. doi: 10.1016/j.jcin.2023.02.004. PMID: 37100559.

A modern PE treatment plan considers major predictors of adverse events

Confirmed PE with one or more of the following:

RV Dysfunction* OR Large, Central thrombus OR Concomitant DVT

Anticoagulation

Sub-segmental thrombus

Medical Treatment Candidate
- Consider Thrombolysis
- Admit to ICU and monitor for hemodynamic changes

Central or Segmental thrombus

Mechanical thrombectomy candidate

Normotensive patients may be sicker than they appear:

Consider lactate, cardiac index, AKI, and HR.

* Defined as: RV/LV > 0.9 [1,2,3], RV hypokinesis on ECHO[4,22], or elevated cardiac Biomarkers[21]

1. Becattini *et al*. Multidetector computed tomography for acute pulmonary embolism: diagnosis and risk stratification in a single test. European Heart Journal (2011)
2. Schoepf *et al*. Right ventricular enlargement on chest computed tomography: a predictor of early death in acute pulmonary embolism. Circulation. 2004
3. George et al. A retrospective analysis of catheter-based thrombolytic therapy for acute submassive and massive pulmonary embolism. Vascular Medicine. 2015, Vol. 20(2) 122–130
4. George *et al*. Computed tomography and echocardiography in patients with acute pulmonary embolism part 2:prognostic value. J Thorac Imaging 2014;29:W7-W12)

21. Chen *et al*. Right ventricular dysfunction is superior and sufficient for risk stratification by a pulmonary embolism response team. Journal of Thrombosis and Thrombolysis 2019
22. Goldhaber *et al*. Acute pulmonary embolism: clinical outcomes in the International Cooperative Pulmonary Embolism Registry (ICOPER). Lancet Vol 353. 1999

INTENDED PURPOSE

The **FlowTriever Retrieval/Aspiration System**'s intended purpose is for use in the peripheral vasculature and pulmonary arteries for the treatment of intermediate- and high-risk pulmonary embolism in patients 18 years or older deemed medically suitable for mechanical thrombectomy.

Indications, Contraindications, warnings, and instructions for use can be found in the product labeling supplied with each device.

Caution: Federal (USA) law restricts this device to sale by or on the order of a physician.

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Thank You

INARI MEDICAL®