Manažment pľúcnej embólie v praxi jedného centra

Mikuláš Huňavý
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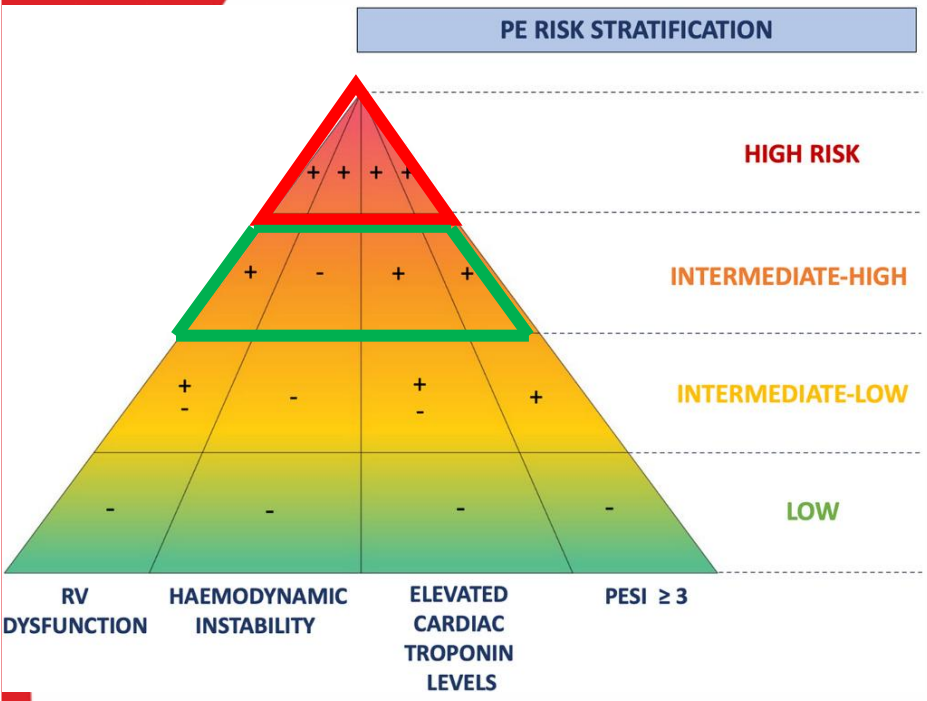
UPJŠ LF a VÚSCH a.s.



Guarnieri et al., Int J Cardiol 2025

(1) Cardiac arrest	(2) Obstructive shock[68–70]	(3) Persistent hypotension
Need for cardiopulmonary resuscitation	Systolic BP < 90 mmHg or vasopressors required to achieve a BP ≥90 mmHg despite adequate filling status	Systolic BP < 90 mmHg or systolic BP drop ≥40 mmHg, lasting longer than 15 min and not caused by new-onset arrhythmia, hypovolaemia, or sepsis
	And	
	End-organ hypoperfusion (altered mental status; cold, clammy skin; oliguria/anuria; increased serum lactate)	

Konstantinides SV et al., Eur Heart J. 2020;41(4):543–603

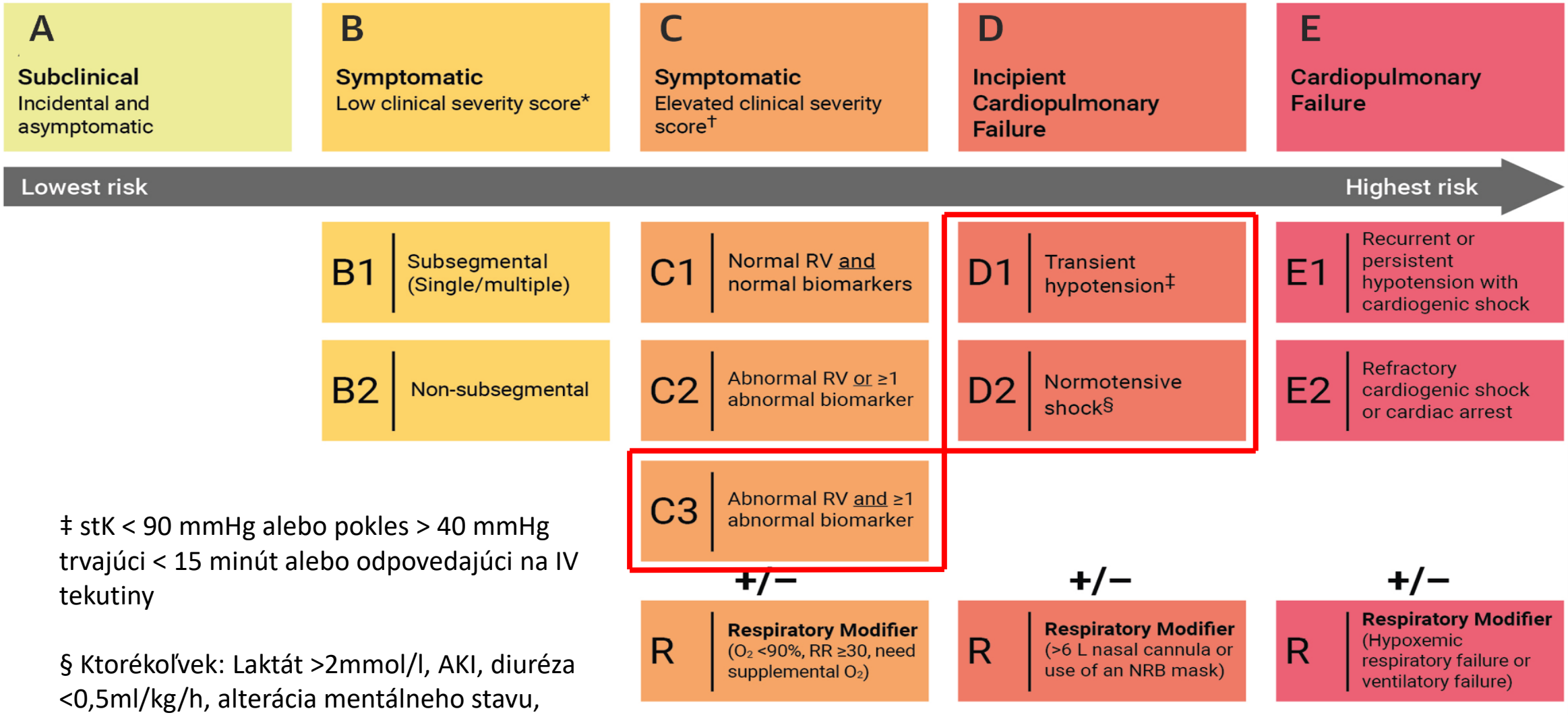
Clinical
– Heart rate >100 bpm
– BP 90-100 mmHg
– Respiratory rate >20 breaths per minute
– SaO_2 <90%
– Comorbidities: chronic heart failure, active neoplasm
Imaging
Echocardiography (at least 1): – RV/LV >1.0 – TAPSE ≤16 mm – Congested IVC
CTPA: – RV/LV >1.0
Laboratory
Elevated cardiac troponin levels or NT-proBNP >600 pg/mL, or serum lactate 2 mmol/L

Physiological parameters	3	2	1	0	1	2	3
Respiration rate (breaths per minute)	≤8		9-11	12-20		21-24	≥25
SpO_2 (%)	≤91	92-93	94-95	≥96			
Any supplemental oxygen		Yes		No			
Temperature (°C)	≤35.0		35.1-36.0	36.1-38.0	38.1-39.0	≥39.1	
Systolic BP (mmHg)	≤90	91-100	101-110	111-219			≥220
Heart/pulse rate (beats per minute)	≤40		41-50	51-90	91-110	111-130	≥131
Level of consciousness, AVPU scale				A			V, P or U

Level of consciousness: A: alert; V: responds to voice; P: responds to pain; U: unresponsive. From National Early Warning Score (NEWS): Standardising the assessment of acute-illness severity in the NHS. Report of a working party. Royal College of Physicians, London, 2012[24]. BP: blood pressure; SpO_2: oxygen saturation

Pruszczyk et al., Eurointervention 2022;18(8):e623-e638.

AHA/ACC Acute PE Clinical Categories



‡ stK < 90 mmHg alebo pokles > 40 mmHg trvajúci < 15 minút alebo odpovedajúci na IV tekutiny

§ Ktorékoľvek: Laktát >2mmol/l, AKI, diuréza <0,5ml/kg/h, alterácia mentálneho stavu, CI<2,2l/min/m2, MAP < 60mmHg, ↑ SCAI stage/CPES score

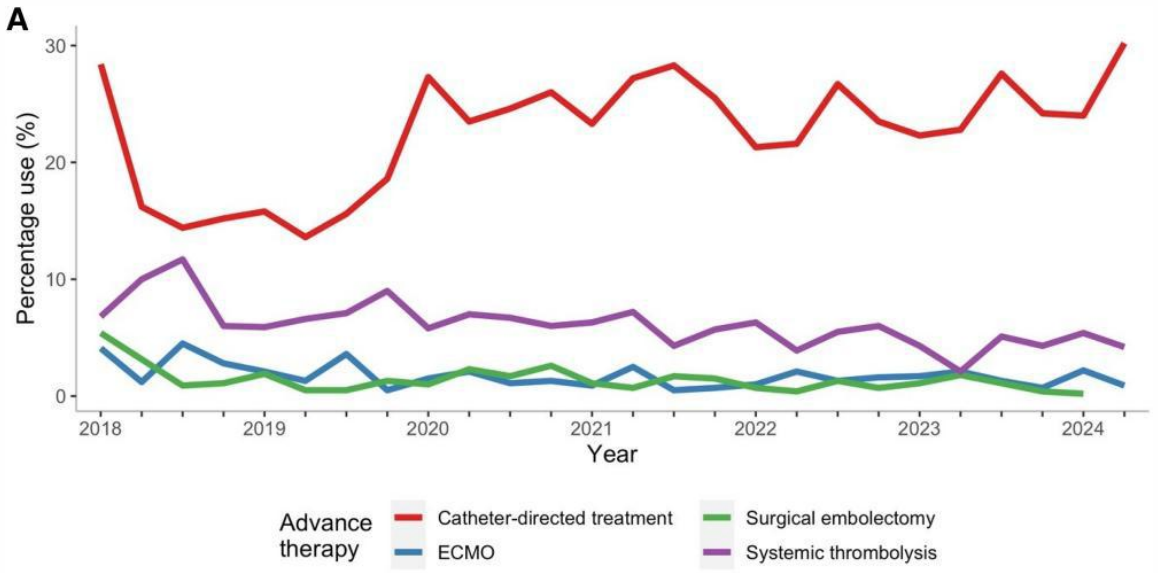
Creager et al., JACC 2026; 87(13):1626-1710

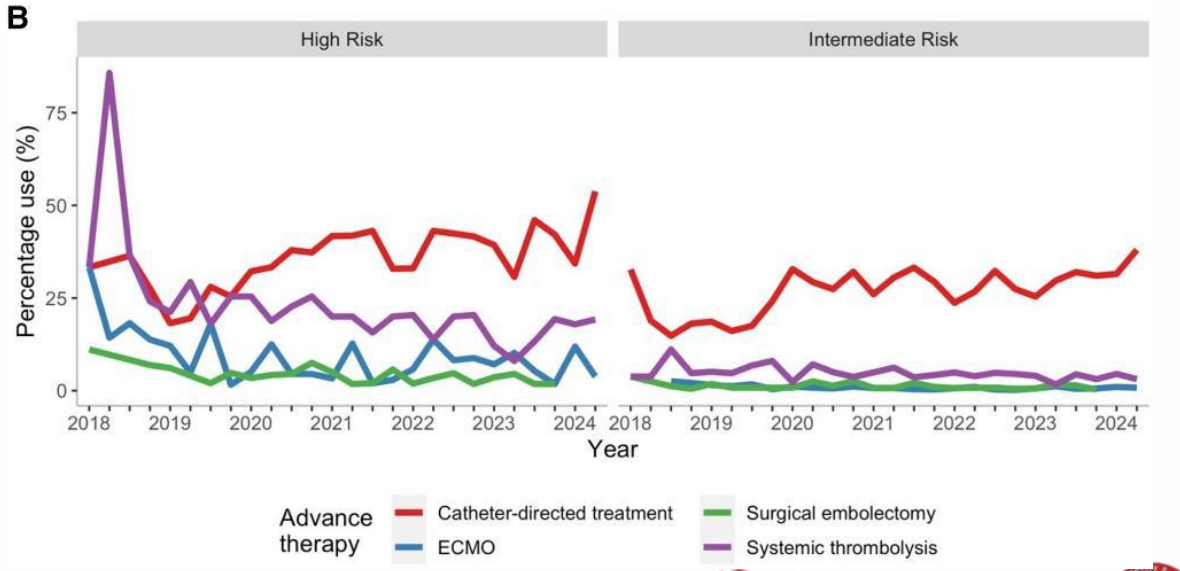
Register PERT Consortium

11,436 patients with acute PE in the PERT Consortium® registry
13.7% high risk, 62.5% intermediate risk
managed from pulmonary embolism reponse teams (PERT)

Catheter-directed treatment	Systemic thrombolysis	Surgical embolectomy	ECMO
23.1% *+0.36% quarterly increase*	**5.6%** *-0.17% quarterly decrease*	**1.1%** *-0.06% quarterly decrease*	**1.6%** *-0.06% quarterly decrease*

Matched comparison to the Nationwide Inpatient Sample
+22% ↑ CDT use
-1.3% ↓ in-hospital mortality
-0.75 ↓ days of hospital stay



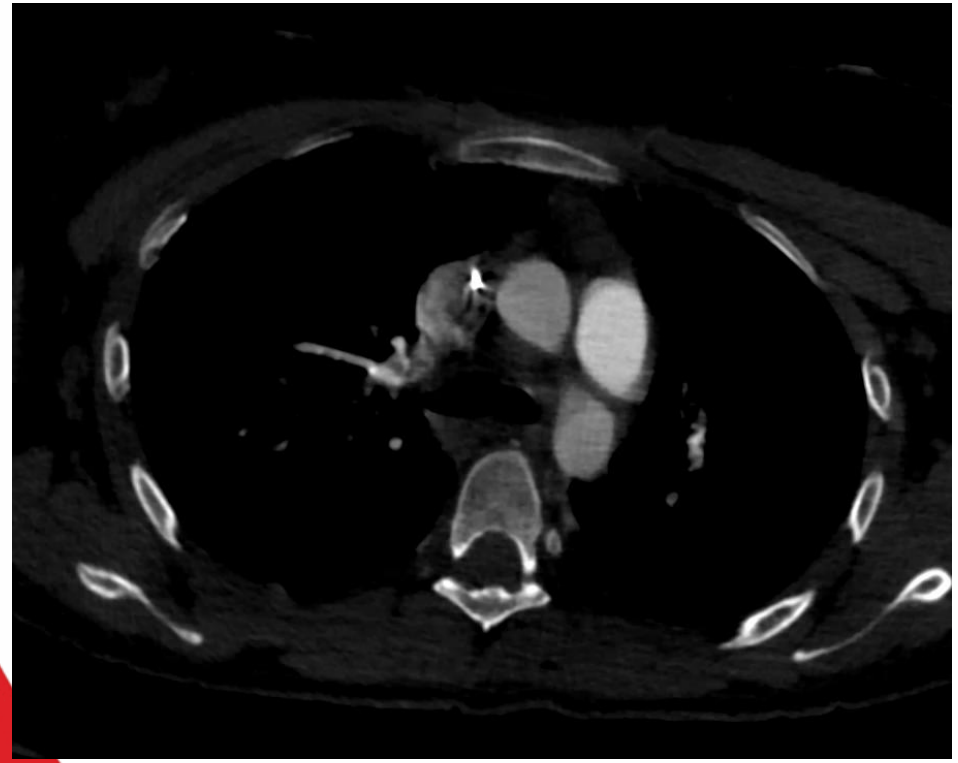


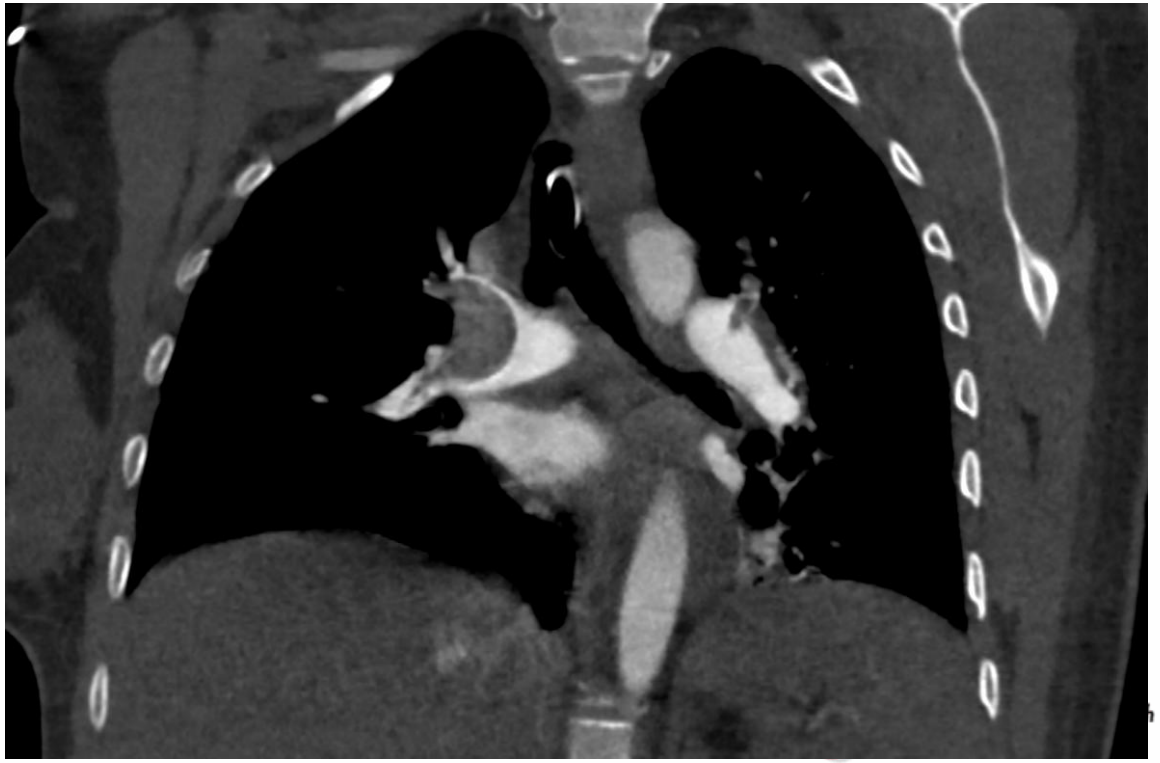
Farmakis et al., EHJ ACC 2026;15:125-133

Východoslovenský ústav srdcových a cievnych chorôb, a.s.

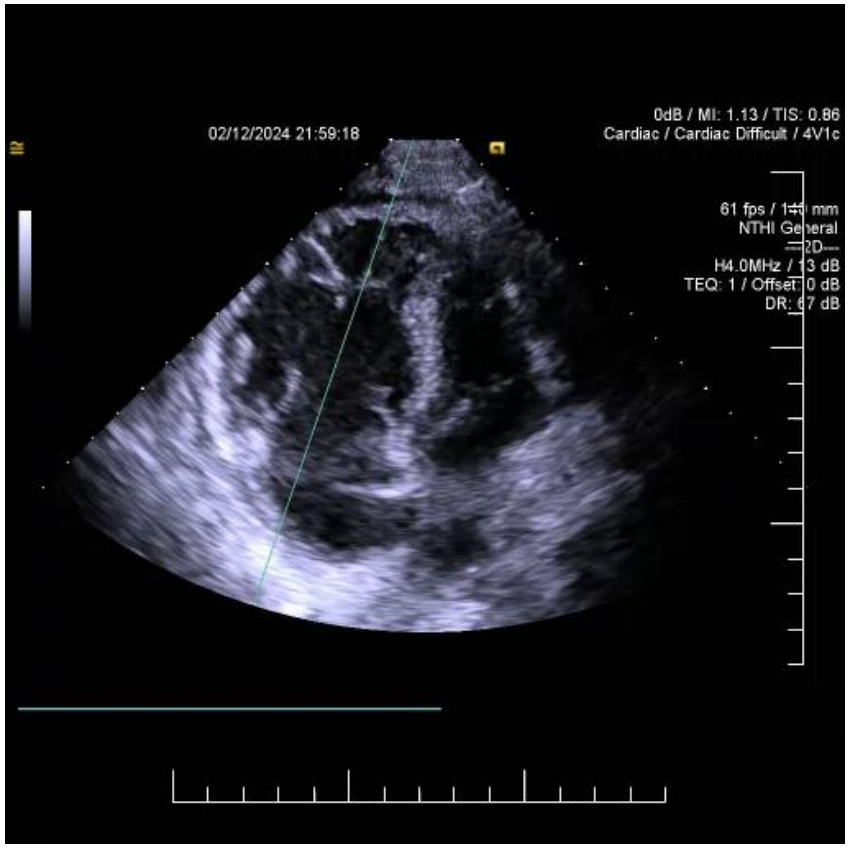
Kazuistika č. 1

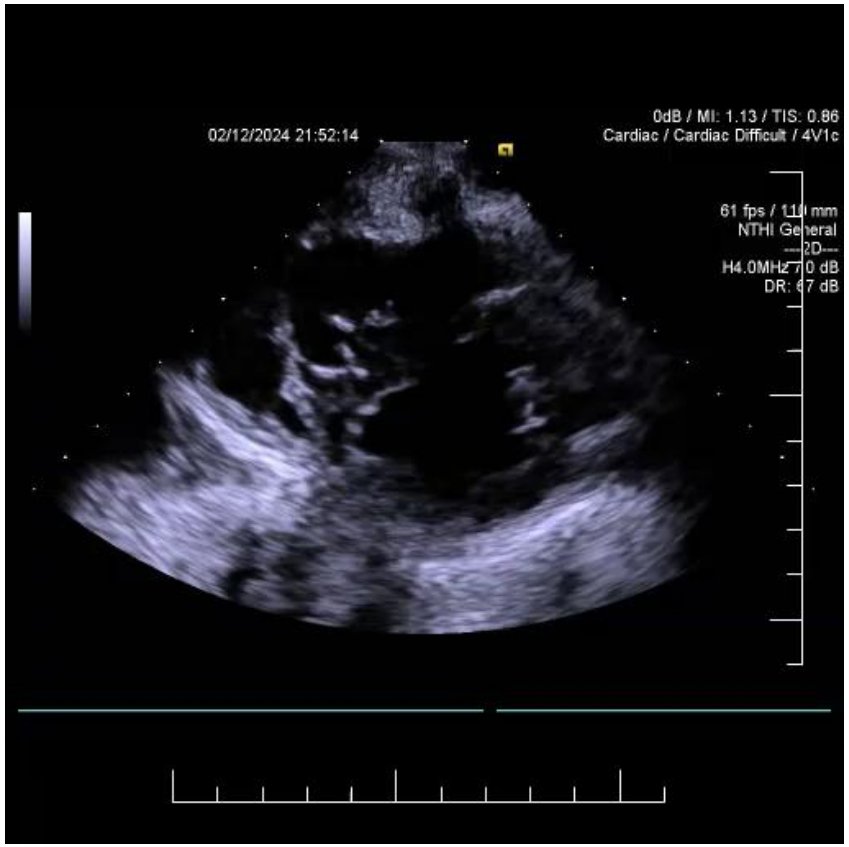
- 27 roč. pacientka, po sec. Caesarea, 3,5 hod. po výkone zástava obehu, opakovanou KPR s ROSC do 5 minút, OTI + UPV
- Bed side TTE dilat. PK, D-shape
- CTPA – masívna PE
- TK 95/60 mmHg (NA 0,06ug/kg/min), CVT 15 mmHg, SF 130/min, SpO2 98% (FiO2 60%)





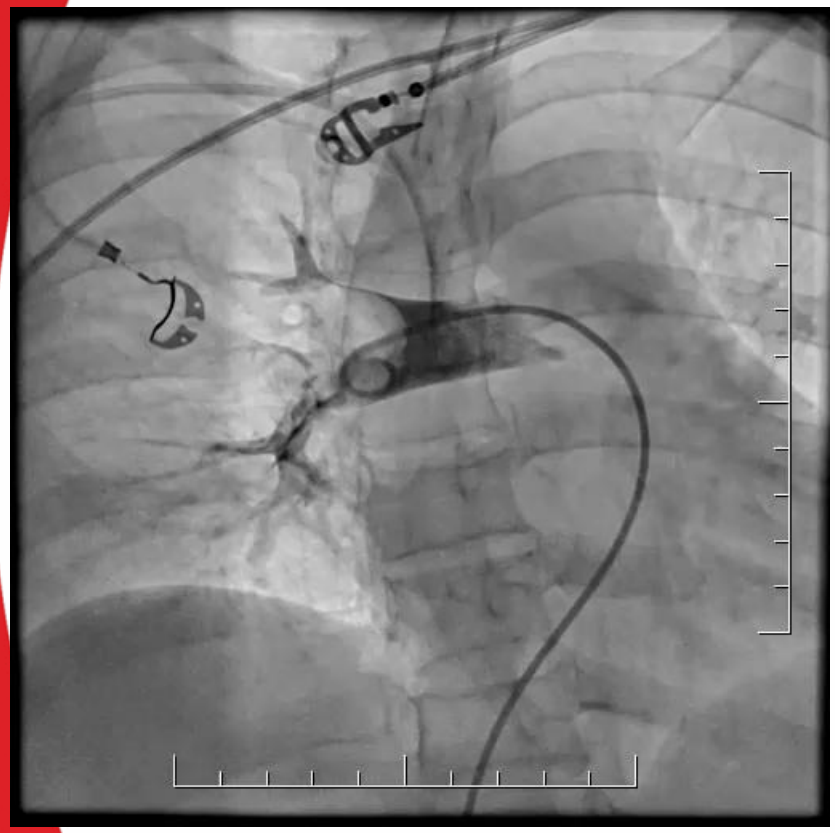
- TNI 1735 ng/l, NTproBNP 983 pg/ml, lakt. 4,6 mmol/l, Hgb 75g/l, PESI 117b (IV), sPESI 3b,
- ESC - High risk, ACC/AHA E2R

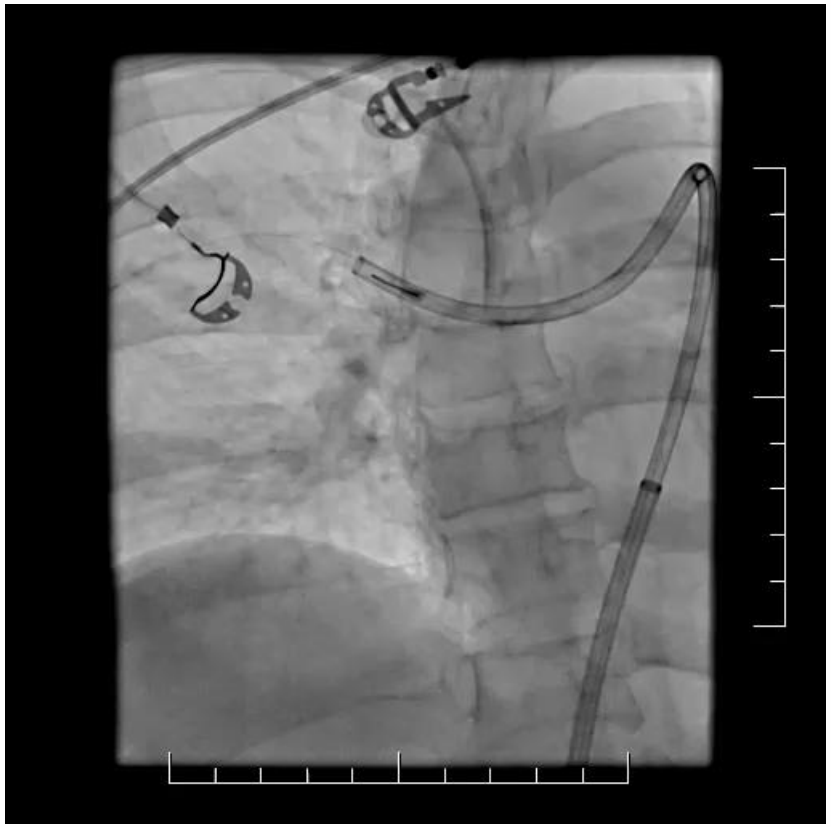


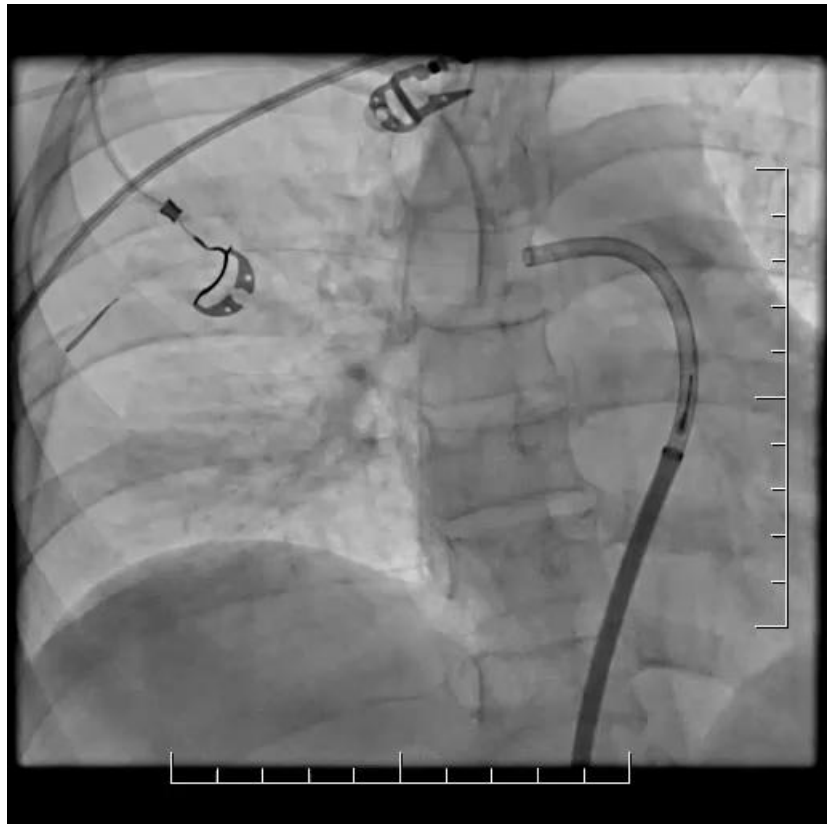


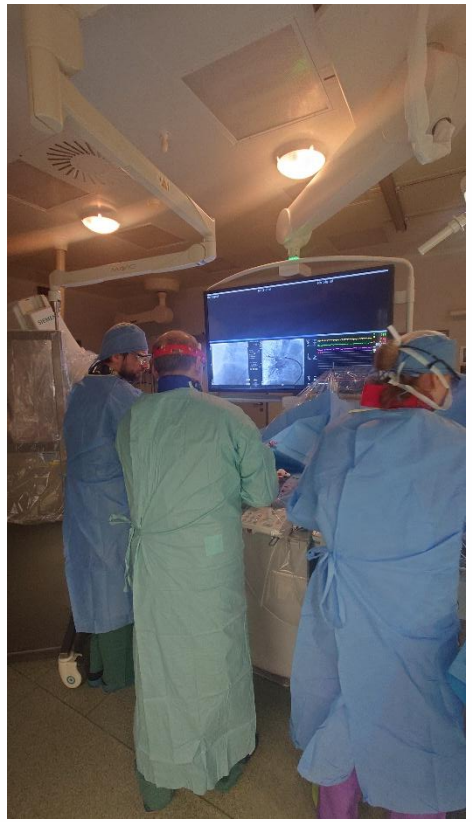
- PERT tím – ECMO (19F ven. Kanyla a 15F art. Kanyla) + MET

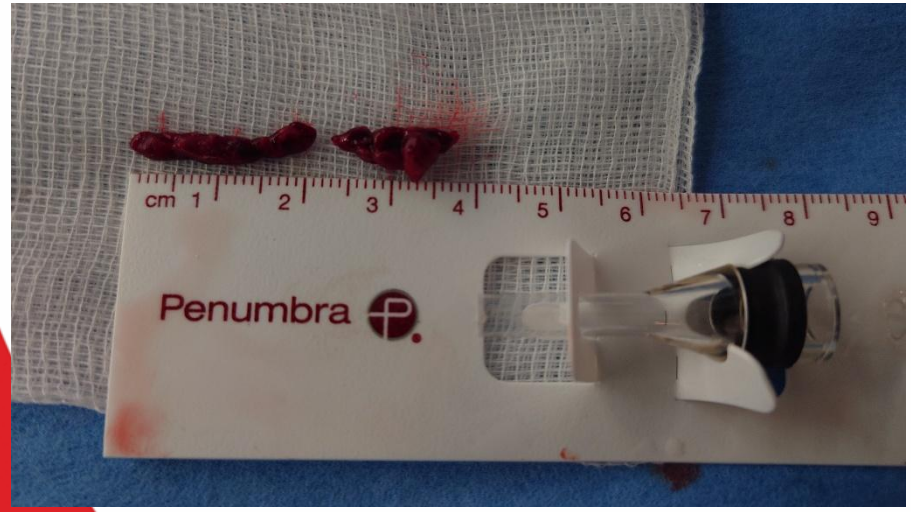
Kazuistika

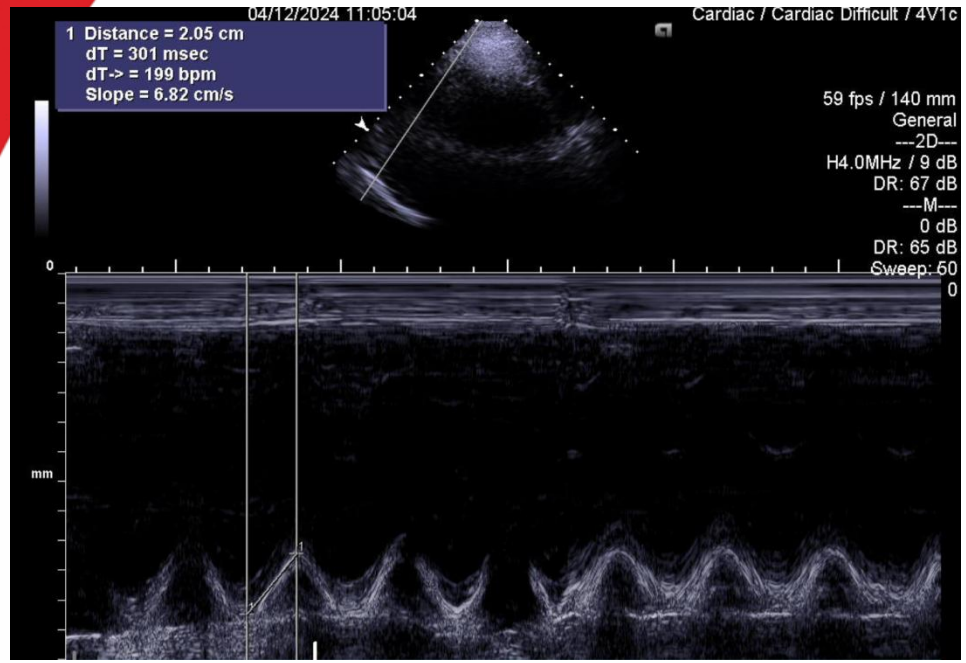


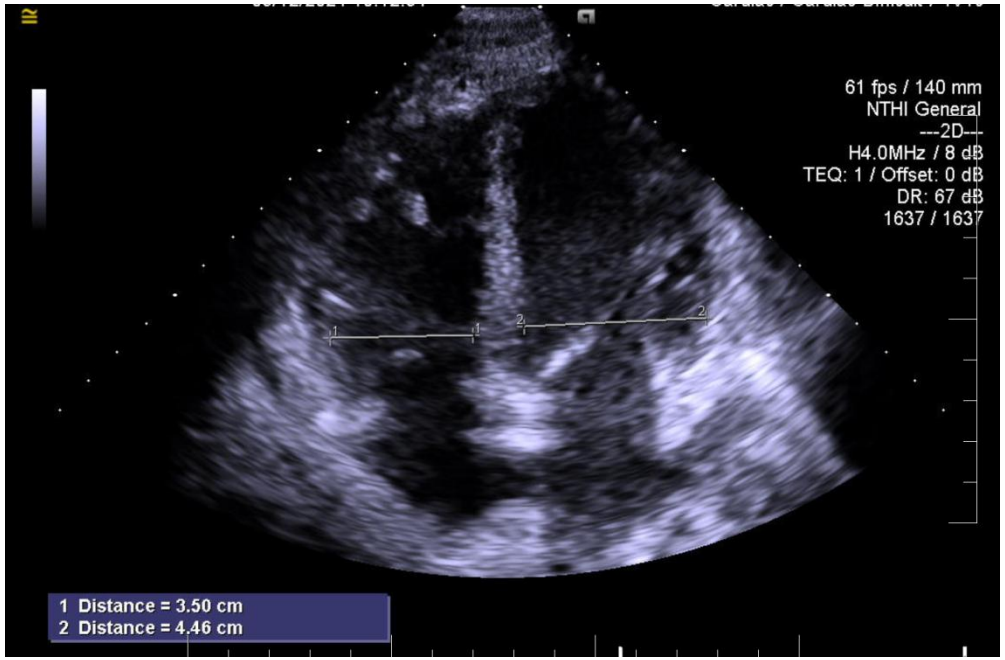


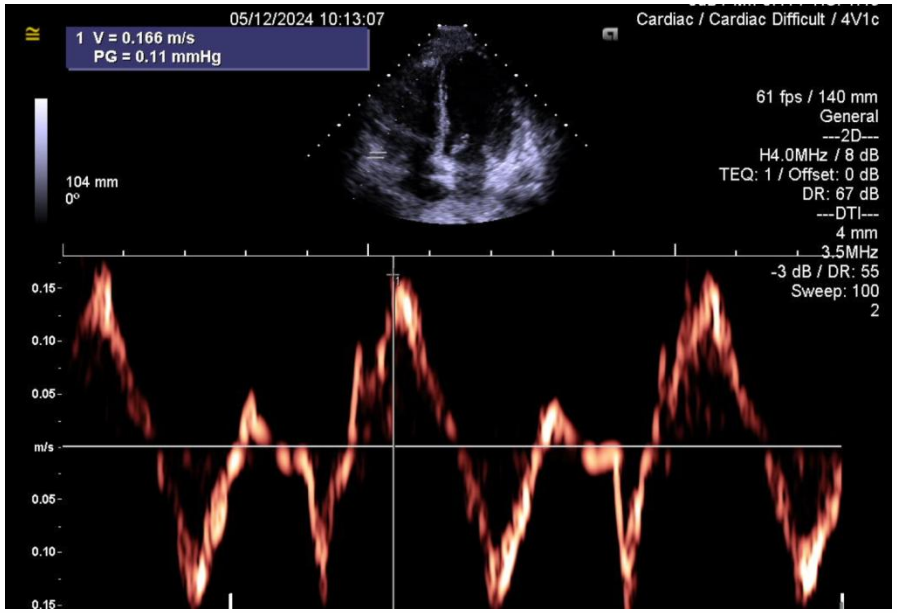


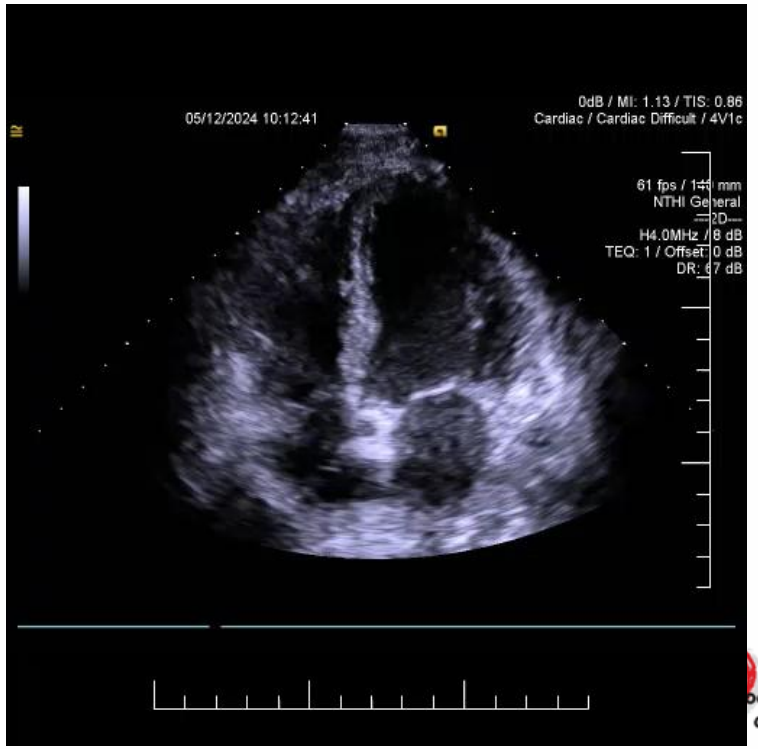


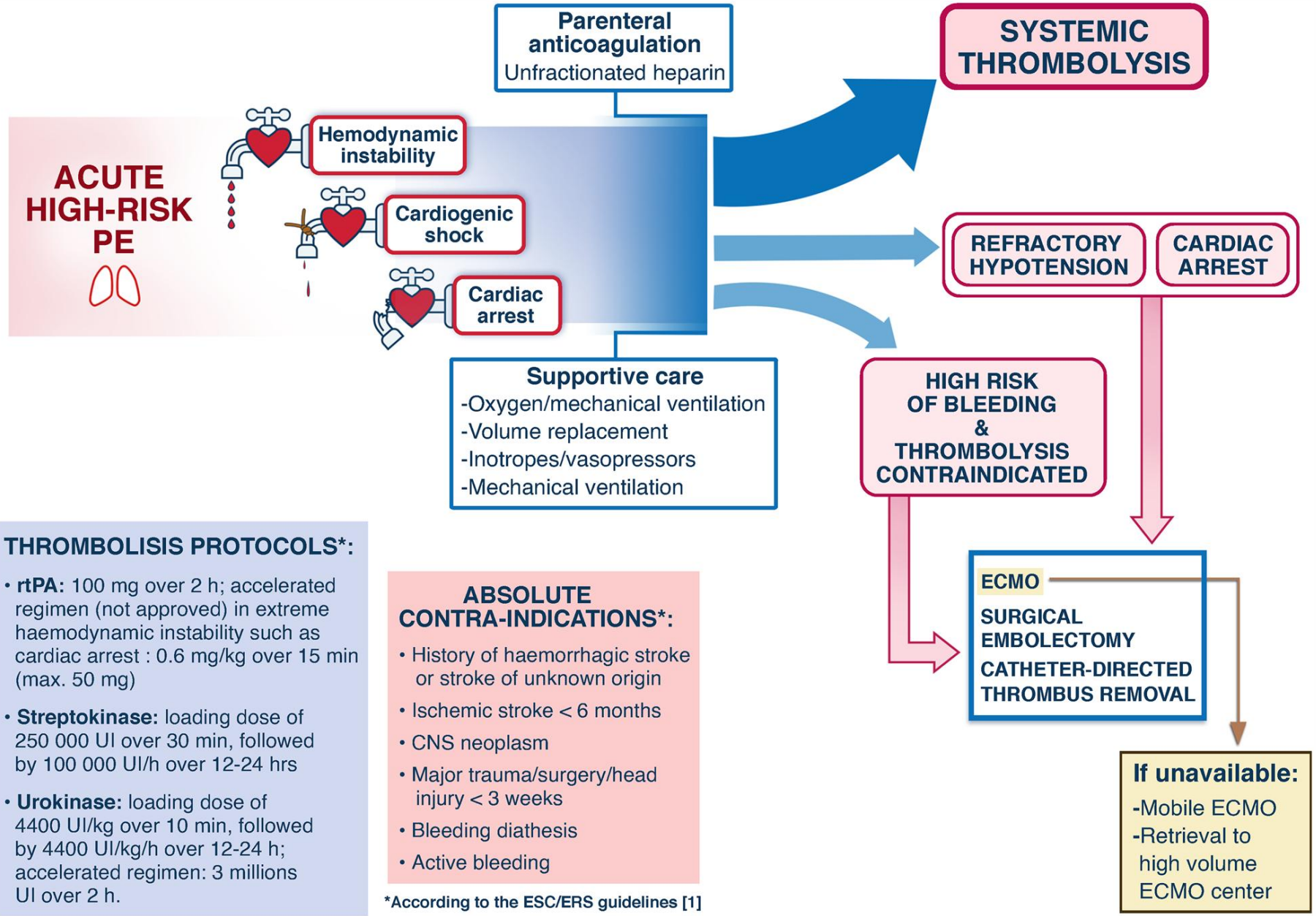

cm 1 2 3 4 5 6 7 8 9
Penumbra


04/12/2024 11:05:04
Cardiac / Cardiac Difficult / 4V1c
1 Distance = 2.05 cm
dT = 301 msec
dT-> = 199 bpm
Slope = 6.82 cm/s
59 fps / 140 mm
General
---2D---
H4.0MHz / 9 dB
DR: 67 dB
---M---
0 dB
DR: 65 dB
Sweep: 60
mm


61 fps / 140 mm
NTHI General
---2D---
H4.0MHz / 8 dB
TEQ: 1 / Offset: 0 dB
DR: 67 dB
1637 / 1637
1 Distance = 3.50 cm
2 Distance = 4.46 cm


05/12/2024 10:13:07
Cardiac / Cardiac Difficult / 4V1c
1 V = 0.166 m/s
PG = 0.11 mmHg
61 fps / 140 mm
General
---2D---
H4.0MHz / 8 dB
TEQ: 1 / Offset: 0 dB
DR: 67 dB
---DTI---
4 mm
3.5MHz
-3 dB / DR: 55
Sweep: 100
104 mm
0°
0.15
0.10
0.05
m/s
0.05
0.10
0.15

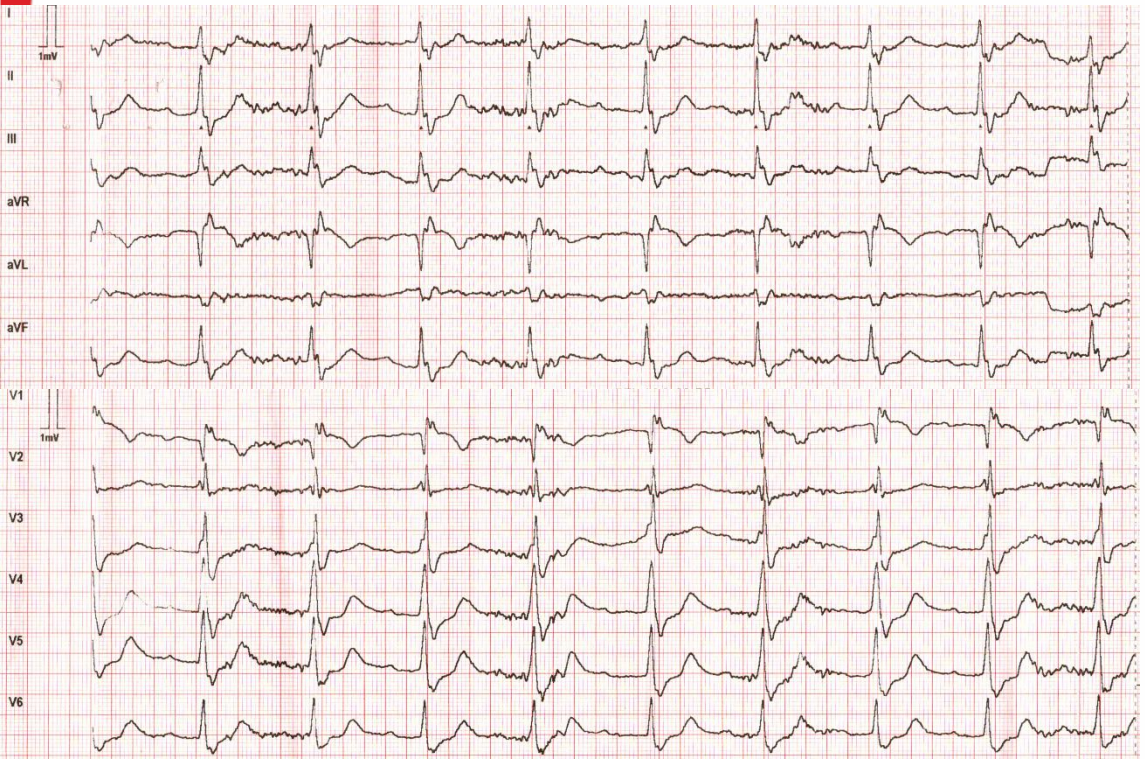

05/12/2024 10:12:41
0dB / MI: 1.13 / TIS: 0.86
Cardiac / Cardiac Difficult / 4V1c
NTHI General
---2D---
H4.0MHz / 8 dB
TEQ: 1 / Offset: 0 dB
DR: 67 dB



Helms et al., Intensive Care Med 2023;49(5):579-582

Kazuistika 2

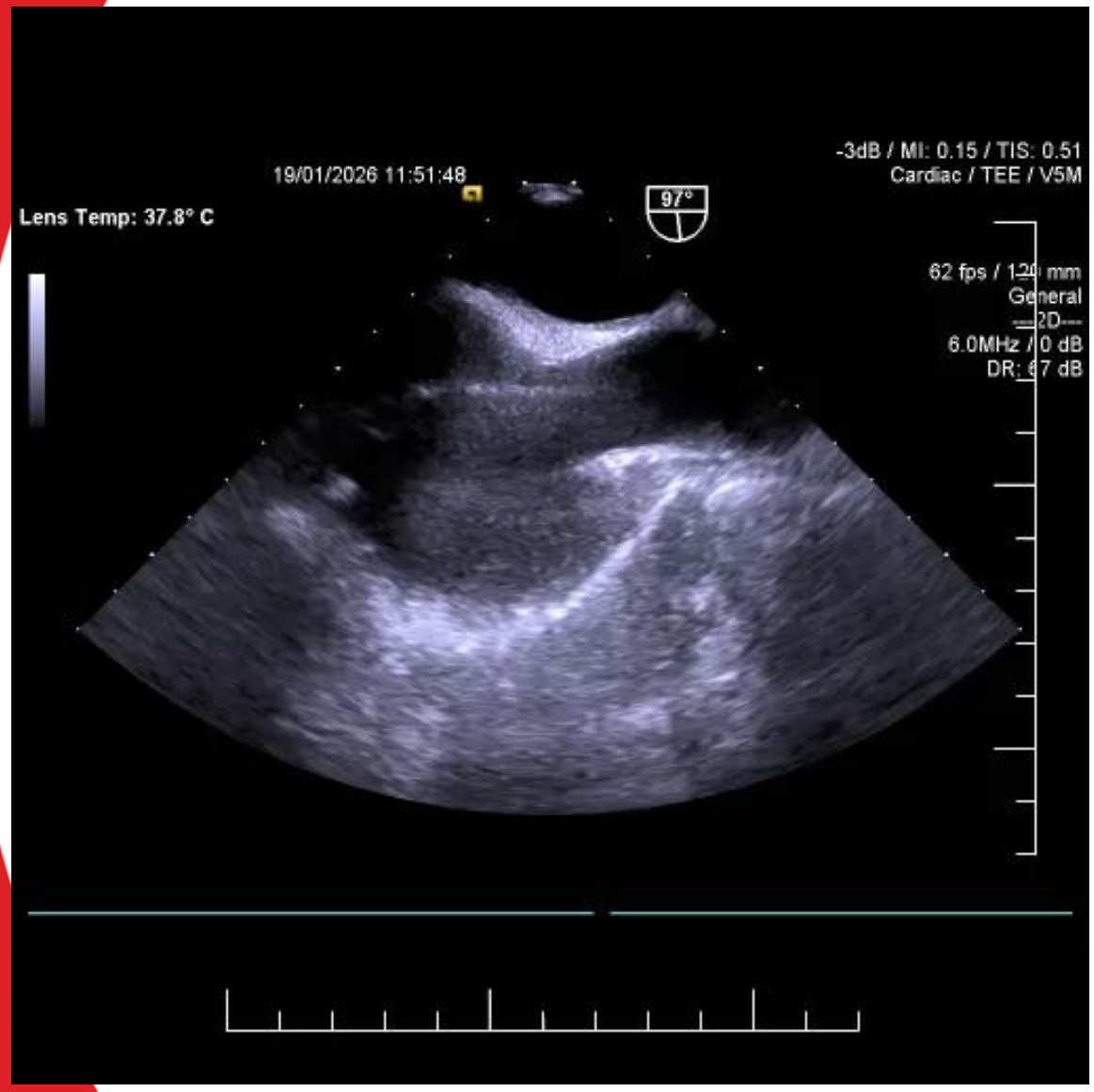
- 43 r. muž, kolaps ráno na toalete, bolesti brucha, dyspnoe, TK PHK 85/50 mmHg, ĽHK nemerateľný, SF 130/min - počas transportu BEA → asystólia
  – OTI+UPV, KPR (LUCAS), čas zástavy 10:27, príchod do VÚSCH 10:59
- EKG: sin. tachykardia, BPTR
- TTE na CPO – dilatácia pravostranných oddielov, podaná Actilyse 50mg/10 min (11:07)
- Zavedenie VA ECMO (11:30) + TEE, Noradrenalín 0,7ug/kg/min, Embessin 2,4IU/h

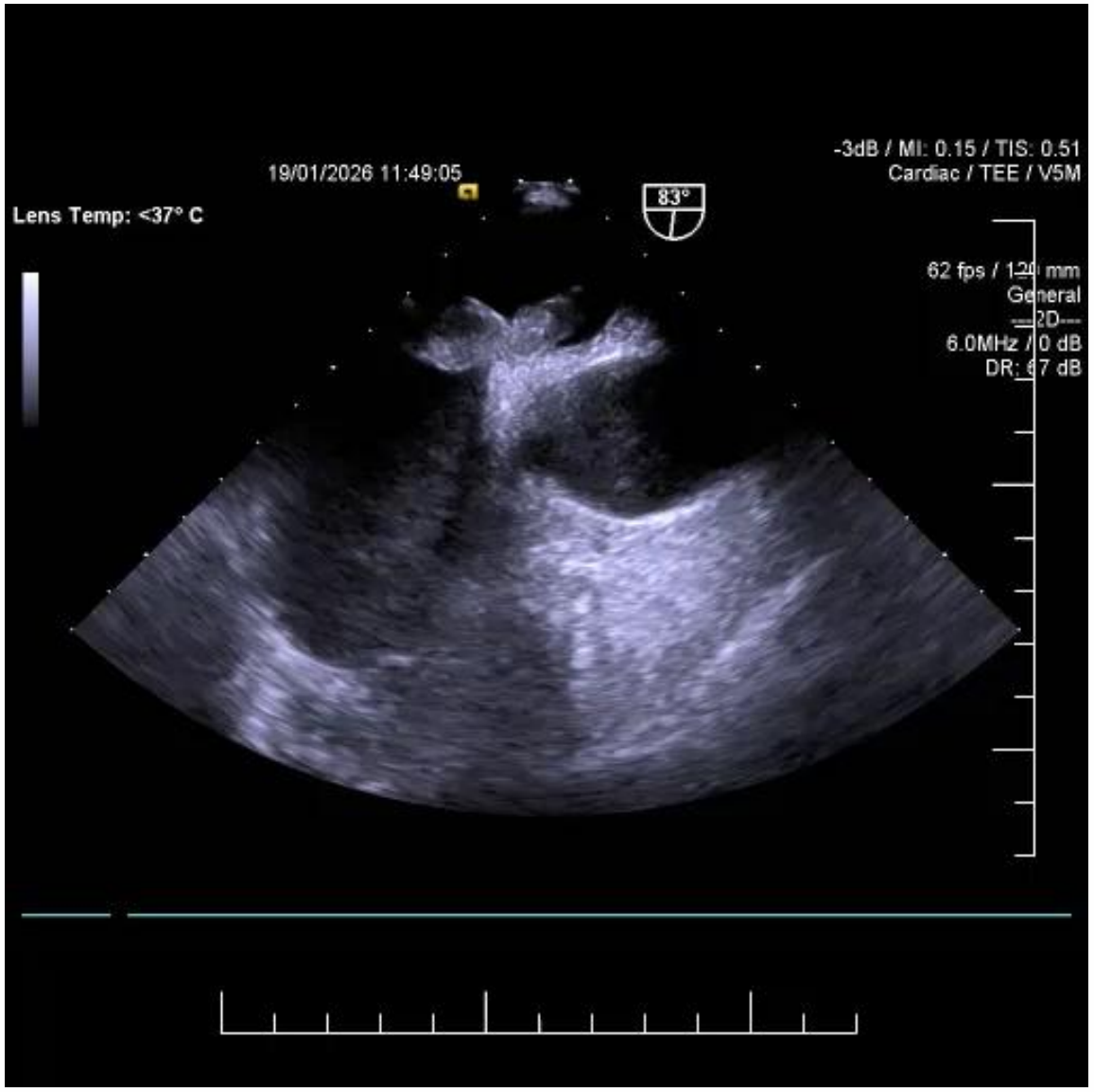


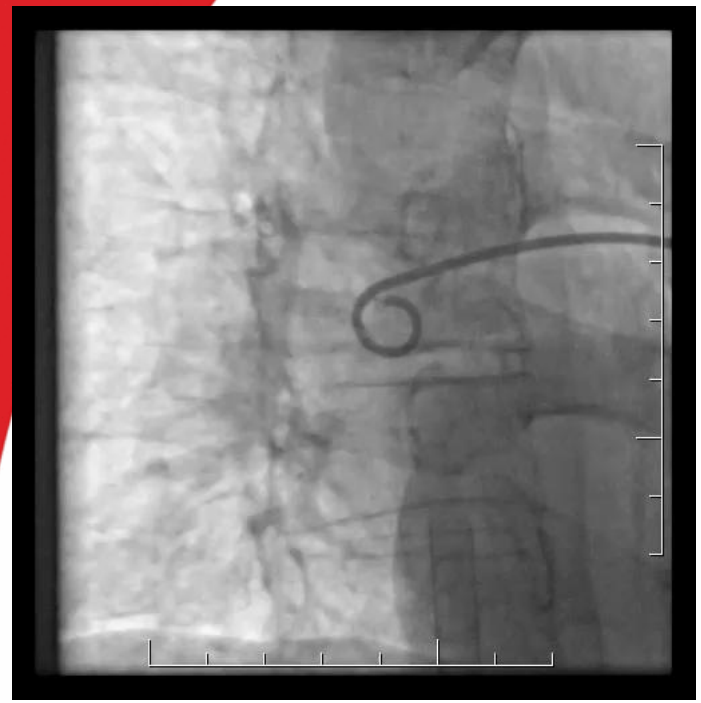
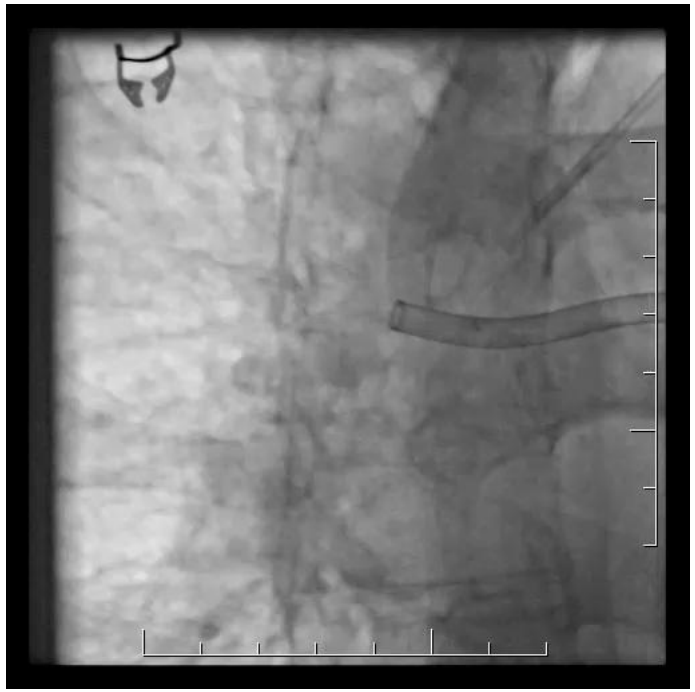
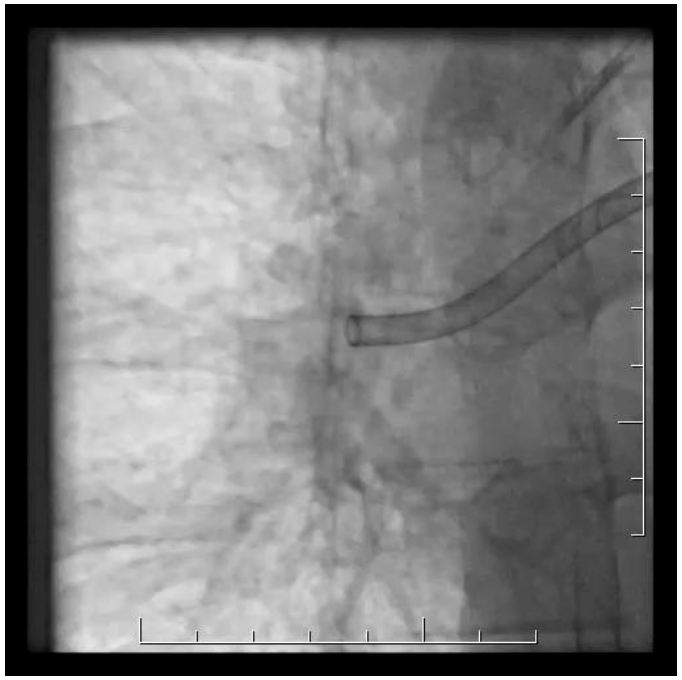
Acido-bazický status			
↓ pH	6,576		[7,320 - 7,420]
↑ pCO2	12,3	kPa	[5,45 - 6,78]
↑ pO2	10,6	kPa	[2,70 - 5,30]
Vypočítané hodnoty			
?↓ ABE,c	-30,3	mmol/L	[-2,5 - 2,5]
↓ SBE,c	-26,0	mmol/L	[-2,5 - 2,5]
↓ cHCO3-(P),c	8,1	mmol/L	[22,0 - 26,0]
↑ mOsm,c	307,0	mmol/kg	[275,0 - 300,0]
Hodnoty elektrolytů			
cNa+	142	mmol/L	[136 - 146]
↑ cK+	5,4	mmol/L	[3,4 - 4,5]
↑ cCl-	115	mmol/L	[98 - 106]
cCa2+	1,30	mmol/L	[-]
Hodnoty metabolitů			
↑ cGlu	22,5	mmol/L	[3,9 - 5,8]
↑ cLac	20	mmol/L	[0,5 - 2,2]
Hodnoty oximetrie			
sO2	63,6	%	[40,0 - 80,0]
ctHb	104	g/L	
FHHb	36,0	%	
Hct,c	32,0	%	
↓ FCOHb	-0,2	%	[0,5 - 1,5]
FMetHb	1,4	%	[0,0 - 1,5]
FO2Hb	62,8	%	[20,0 - 100,0]

Východoslovenský ústav srdcových a cievnych chorôb, a.s.

TEE

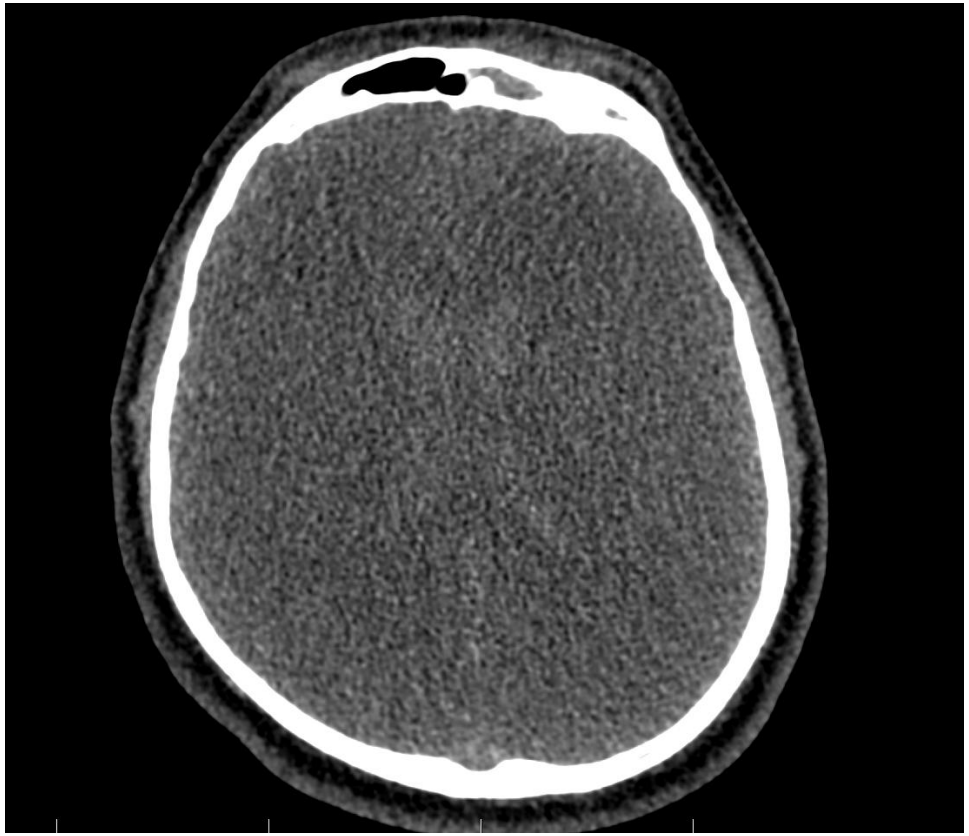

19/01/2026 11:51:48
-3dB / MI: 0.15 / TIS: 0.51
Cardiac / TEE / V5M
Lens Temp: 37.8° C
97°
62 fps / 120 mm
General
2D
6.0MHz / 0 dB
DR: 67 dB


19/01/2026 11:49:05
-3dB / MI: 0.15 / TIS: 0.51
Cardiac / TEE / V5M
Lens Temp: <37° C
83°
62 fps / 120 mm
General
2D
6.0MHz / 0 dB
DR: 67 dB

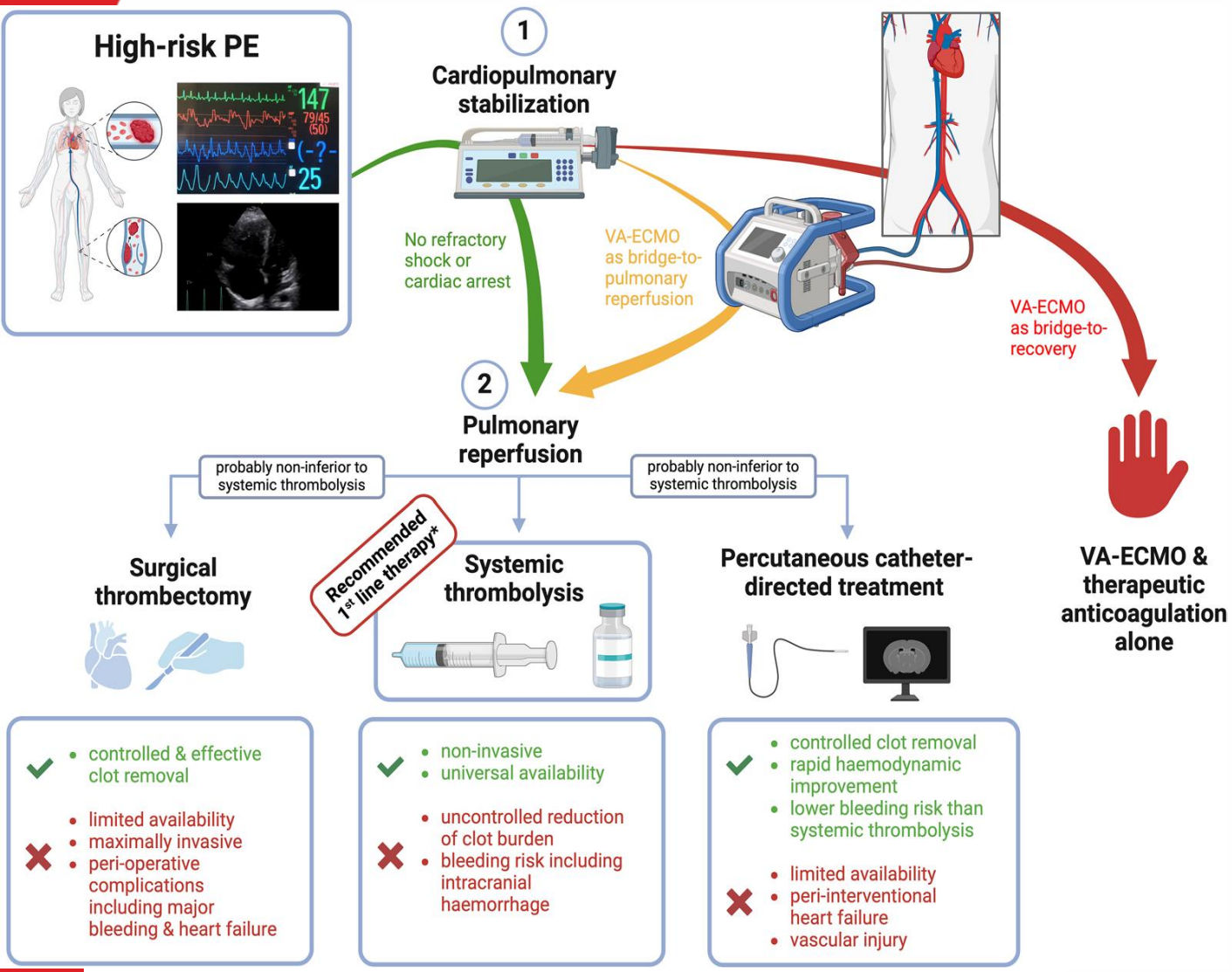




CT mozgu

- Malígny edém mozgu s tonzilárnou herniáciou a kompresiou 3. a 4. mozg. komory.
- Bez jednoznačne diferencovateľnej kontrastnej náplne v artériach Willisovho okruhu, extrakraniálne artérie so suboptimálnou náplňou.
- Uzáver AMI. Distálne stenózy viscerálnych vetiev.



ECMO – most alebo destinačná liečba?



Hunsicker et al., Intensive Care Med 2025; 51:773-775

ECMO may be considered, in combination with surgical embolectomy or catheter-directed treatment, in patients with PE and refractory circulatory collapse or cardiac arrest.[d 252]	IIb	C

Konstantinides SV et al., Eur Heart J. 2020;41(4):543–603

COR	LOE	RECOMMENDATIONS
2a	B-NR	2. In patients with acute, refractory cardiogenic shock as a result of known or suspected acute PE (AHA/ACC PE Category E2), it is reasonable to institute VA-ECMO, provided appropriate resources are available, to stabilize hemodynamics and improve oxygenation.[3-6]
2b	C-LD	3. In patients with acute PE in AHA/ACC PE Category E2 who are placed on VA-ECMO support, the usefulness of additional advanced therapies is not well established.[7-9]

Creager et al., JACC 2026; 87(13):1626-1710

ECMO – most alebo destinačná liečba?

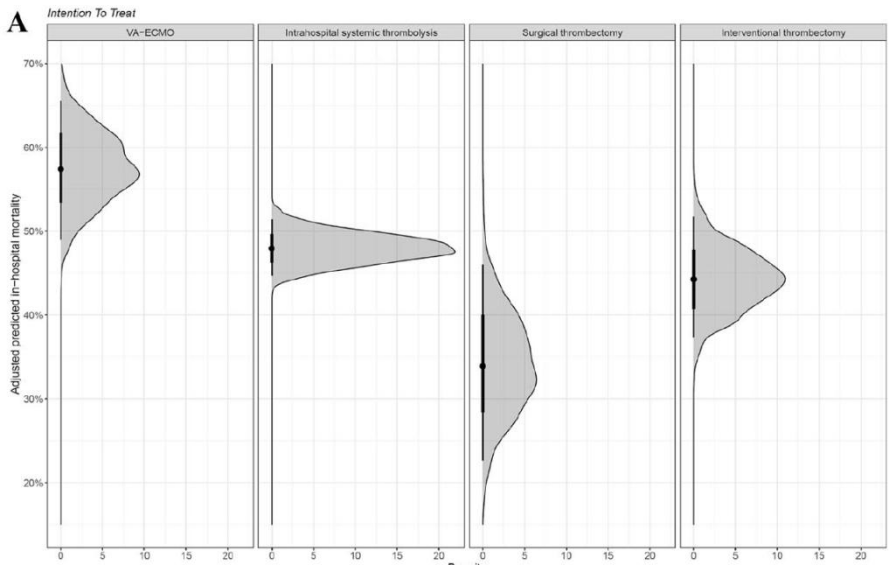
- Retrospektívne dáta 1060 pacientov s High-Risk PE, 34 centier (2012-2022)
- Tzv. „trial emulation“ napodobňujúca dizajn RCT

VA ECMO	Systémová TLL	Chirurgická embolektómia	Katétrová liečba
N=126	n=643	N=49	N=173
	ECMO 30,2%	ECMO 53,1%	ECMO 24,3%

73%	Celková mortalita	44%
47,6%	Závažné krvácanie	26%

ECMO vs. Reperfúzna liečba (±ECMO)

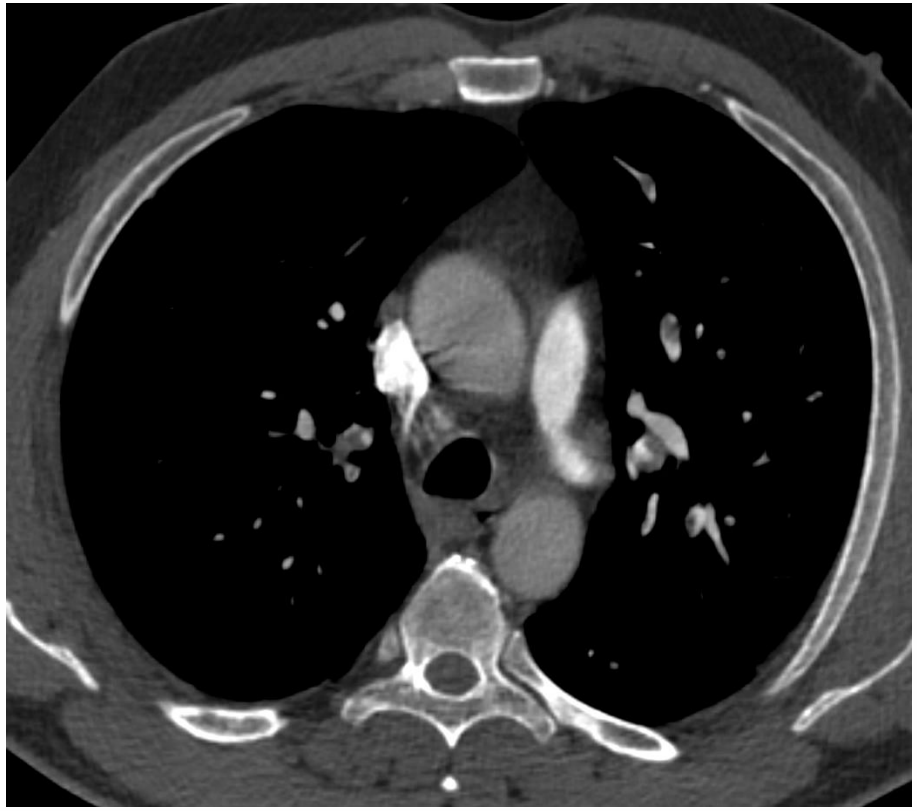
↑ celkovej mortality (OR 1,34; 95% CI 1,07-1,67)



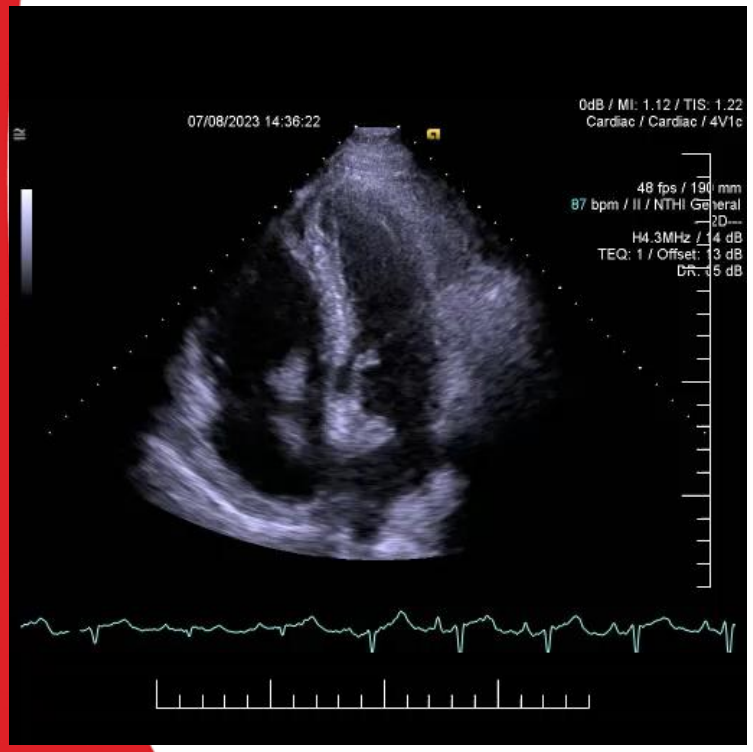
Intensive Care Med (2025) 51:490-505

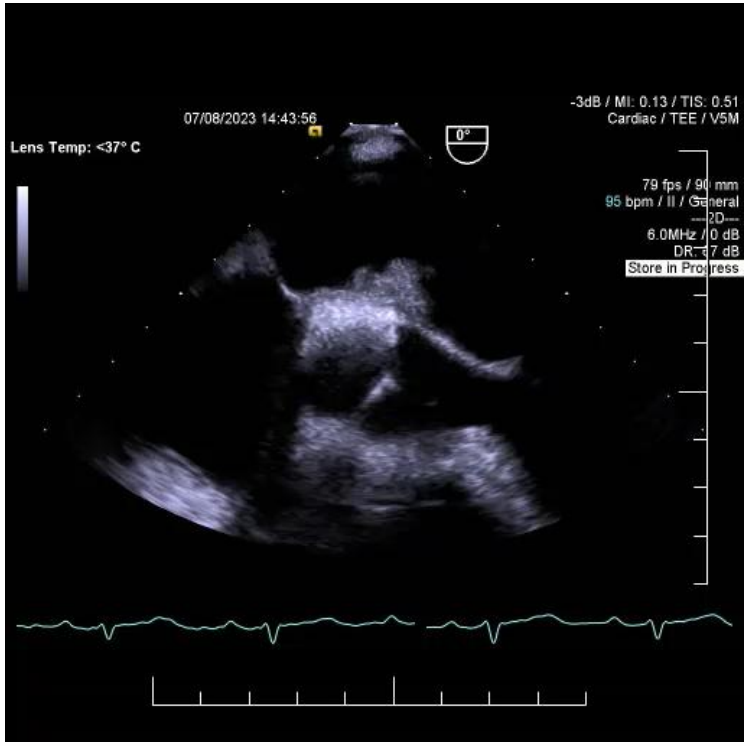
Kazuistika 3

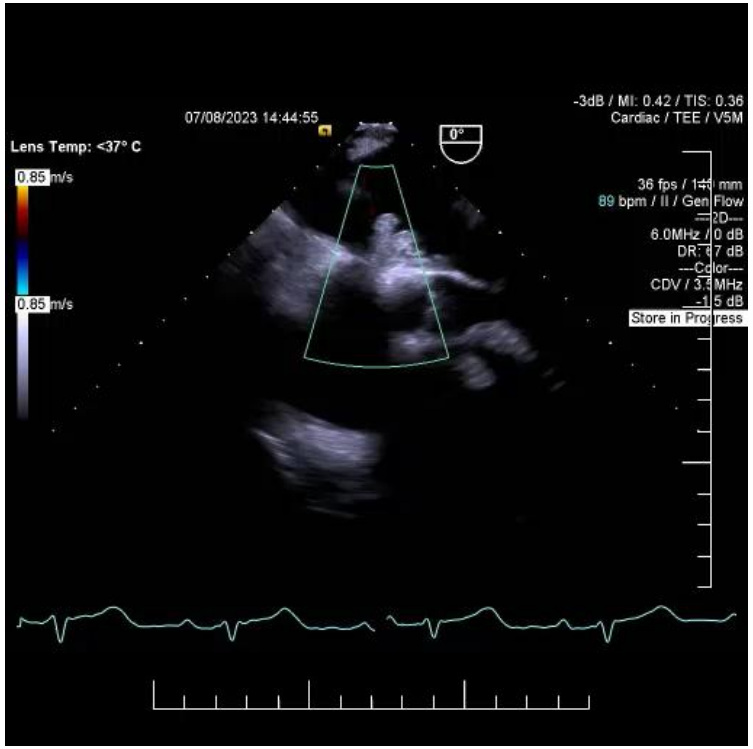
- 51 r. muž, st. p. trombóze ĽDK (FV Leiden heterozygot), synkopa, TK 102/67 mmHg, SF 115/min, DF 25/min, SpO2 87%, pravostranná hemiparéza deň pred príjmom na pár minút
- CT-PA: bilat. PE; CT mozgu: F vľavo subkortikálne hypodenzná area 10mm
- TNI 2687 ng/l, NTproBNP 1487 pg/ml, RV/LV 1,09, lakt. 0,9 mmol/l, PESI 101b (III), sPESI >1



- TK: 130/76 mmHg, SF 85/min, DF 18/min, SpO2 94-95% bez O2
- TTE+TEE: tranzitný trombus 30x5mm v ĽP a 42x8mm v PP v DPS secundum s ĽP skratom
- PERT tím: Chirurgická embolektómia (MTE – riziko syst. embolizácie, TLL – riziko embolizácie a KI pre recentnú NCMP)

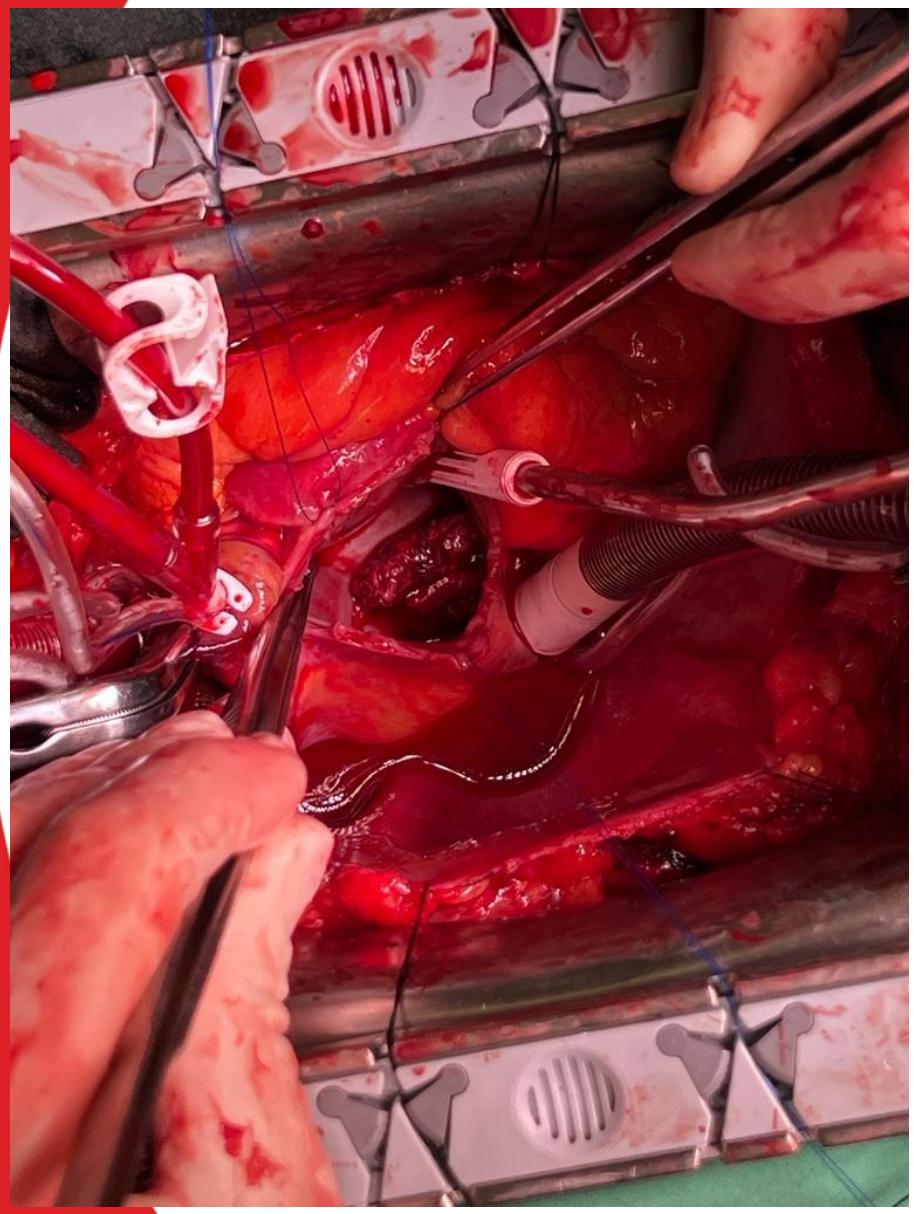






Východoslovenský ústav srdcových a cievnych chorôb, a.s.

Chirurgická embolektómia



Trombus v prechode/uviaznutý v PFO

- Prítomný v cca. 2-4% pacientov
- 358 pac. s trombom prichyteným v PFO
- 13% nemocničná mortalita, 21,2% ischemická NCMP, 4,6% akútny IM
- Akútny IM - ↑ celkovej mortality (OR 7,83; 95%CI 2,7-22,7; p<0,001)
- Chirurgická trombektómia - ↓65% nemocničnej mortality (OR 0,35; 95%CI 0,18 – 0,70; p=0,003)

Logistic regression model in-hospital death.

Variable	Odds Ratio	95% Confidence Interval	P-value
Male sex	1.70	0.90–3.21	0.10
Age, per year	1.02	0.997–1.04	0.10
Myocardial infarction	7.83	2.70–22.7	<0.0001
Surgical thrombectomy	0.35	0.18–0.69	0.002

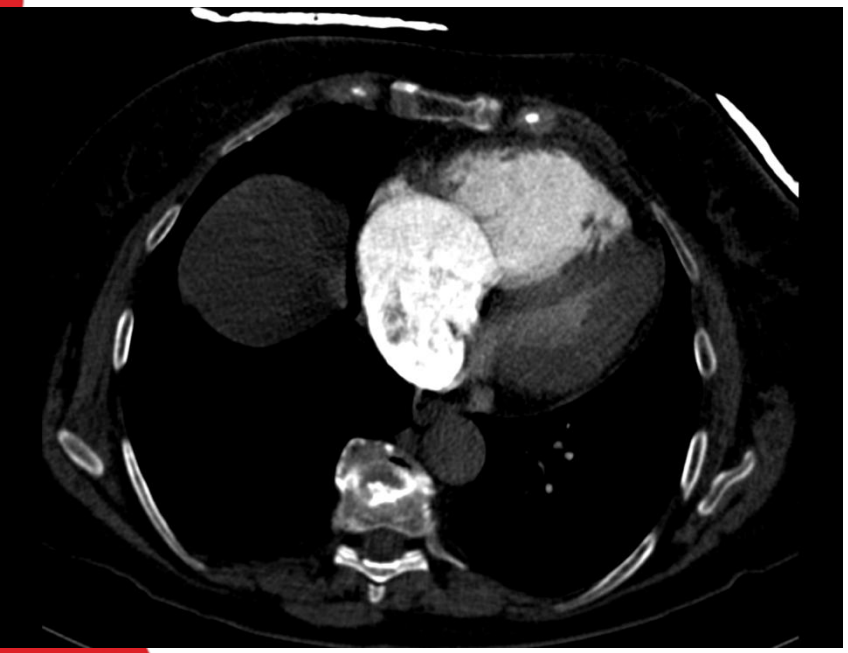
Shah et al. Int J Cardiol 2021;342:1-6

COR	LOE	RECOMMENDATIONS
2a	C-LD	1. In patients with acute PE in AHA/ACC PE Categories C3-E2 who have evidence of free-floating right atrial and/or RV clot-in-transit, the utilization of advanced therapies over anticoagulation alone is reasonable to reduce the risk of clinical deterioration.[1]

Creager et al., JACC 2026; 87(13):1626-1710

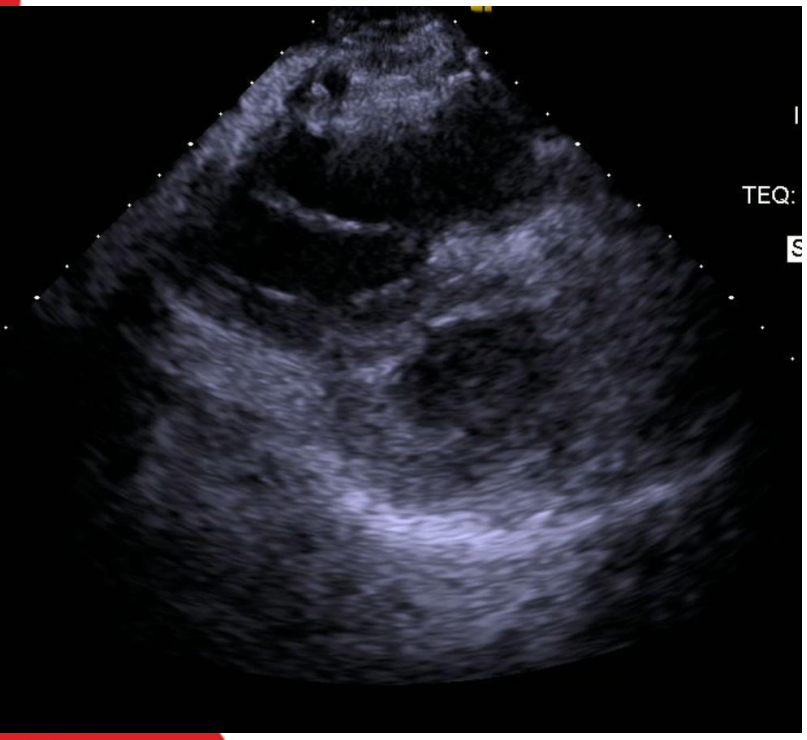
Kazuistika 4

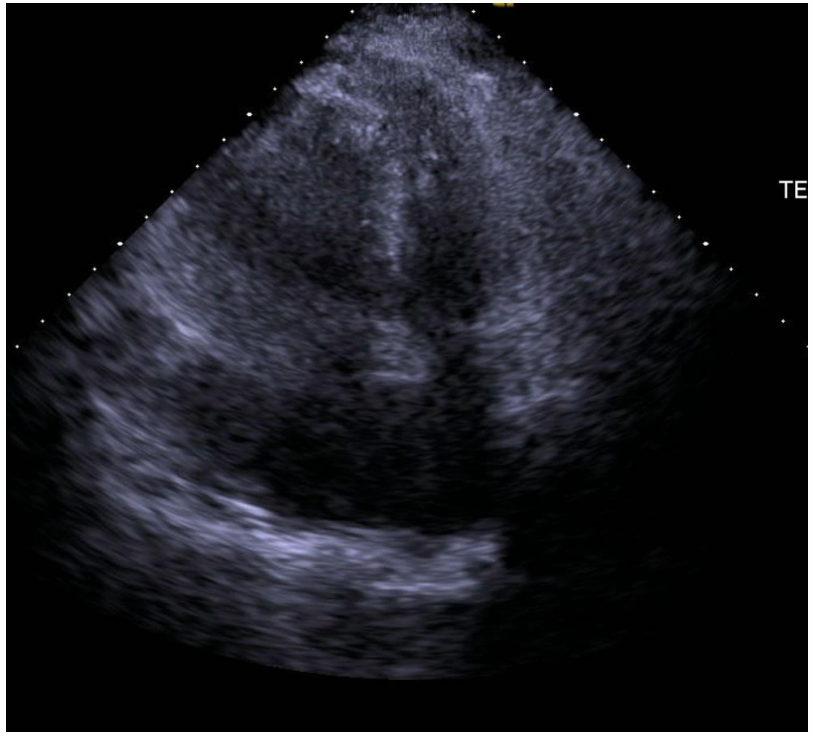
- 68 r. pacientka, synkopa, dyspnoe, sTK 80/50 mmHg (NA 0,07ug/kg/min), SF 110/min, RR 20/min, SpO2 80%, EKG S1, Q3, T3, PESI 151b (V), sPESI 4b;
- ESC – High Risk; ACC – AHA E1R-
- TNI 450,8 NTproBNP 14601, A-Lakt 2,7 mmol/l, Hgb 144g/l
- CT – masívna PE, susp. Tu ezofágu

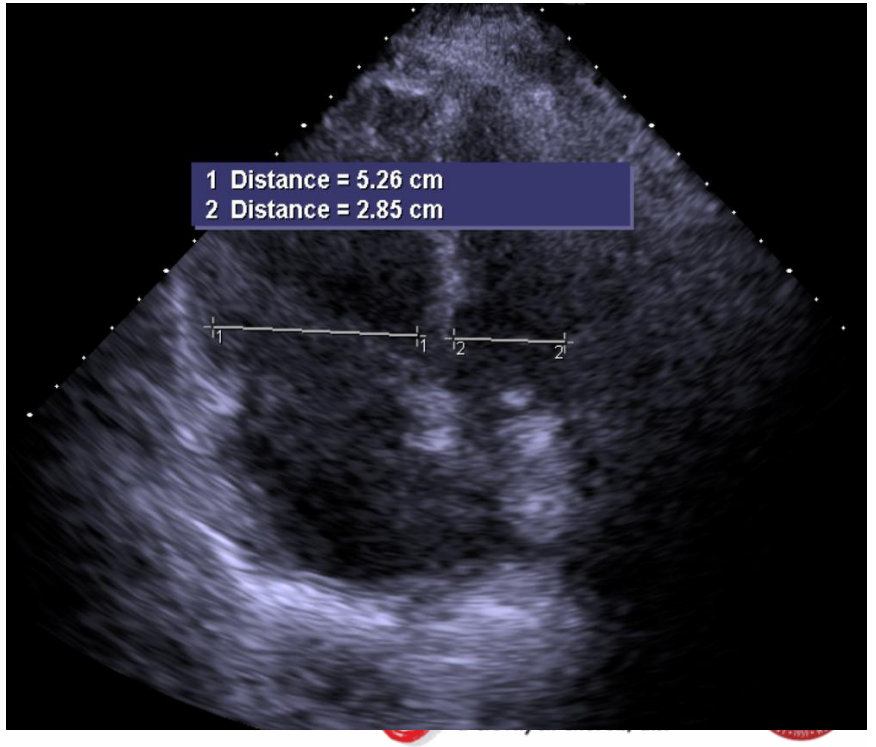


TTE

- TTE – D-shape, LV/RV 1,84, TAPSE 11mm
- UFH i.v.
- Angiológ/kardiológ – rozhodnutie o EKOS





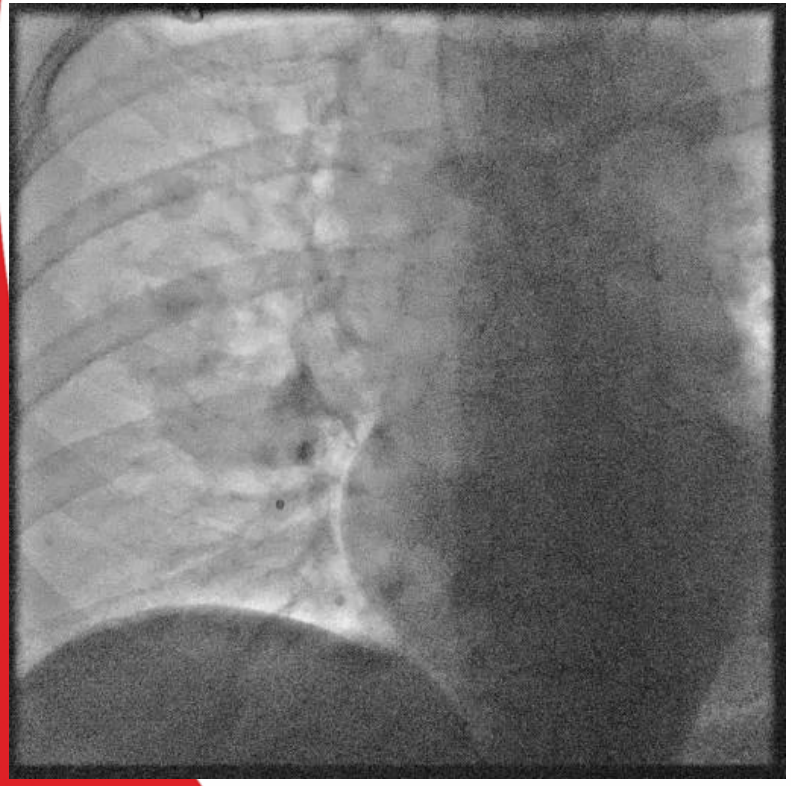


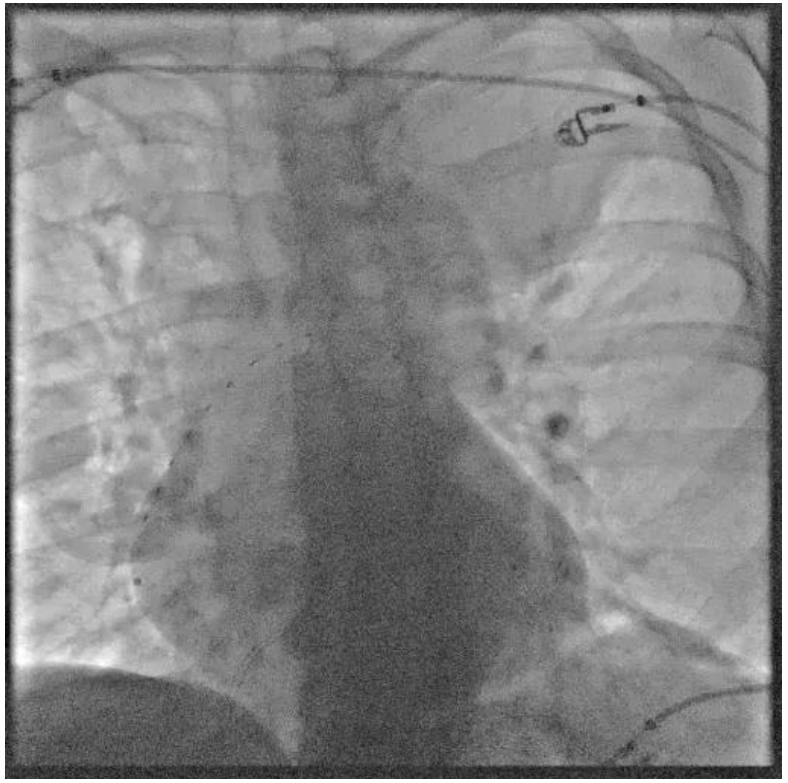
Katétrová liečba – EKOS

- 2x F1/1 50ml + Actilyse 4 mg injektomatom 6,25ml/hod (celkovo 8mg - 8 hod.)
- 2x F1/1 1000ml + Heparin 1000IU infúzomatom 35ml/hod

3: No Benefit	B-NR

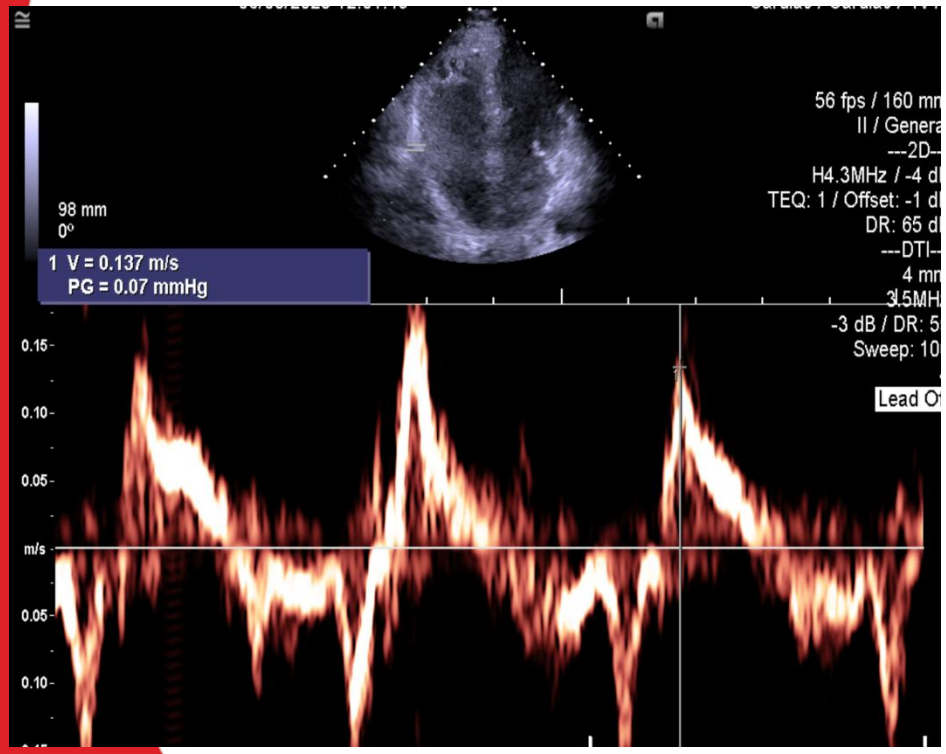
5. In patients with acute PE who are undergoing CDL, a reduced thrombolytic dose of <5 mg of alteplase per PA is not recommended over a standard dose of 5 to 10 mg of alteplase per PA to reduce the risk of bleeding and/or reduce the rate of fatal or nonfatal clinical deterioration.[3,5]

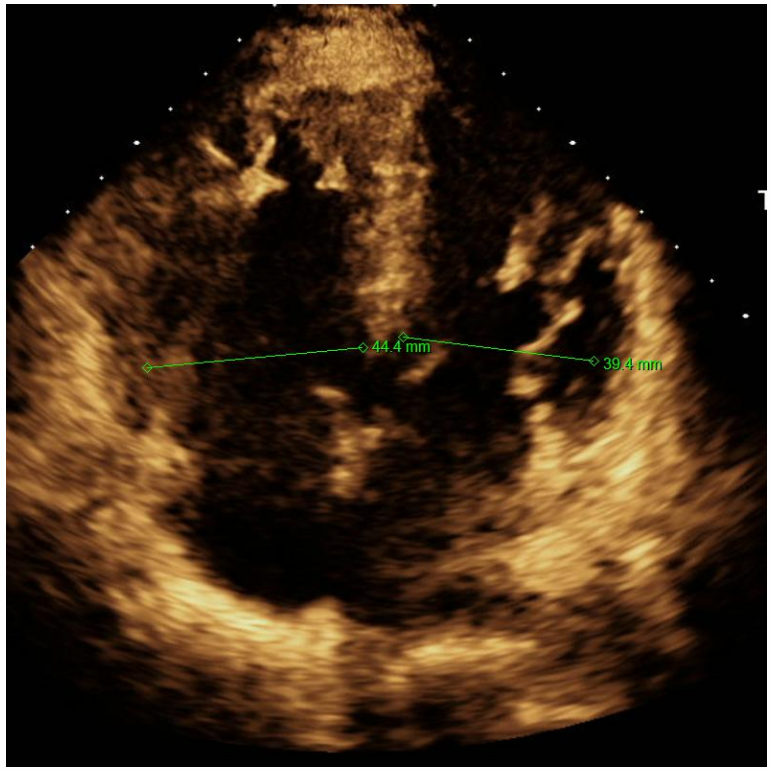


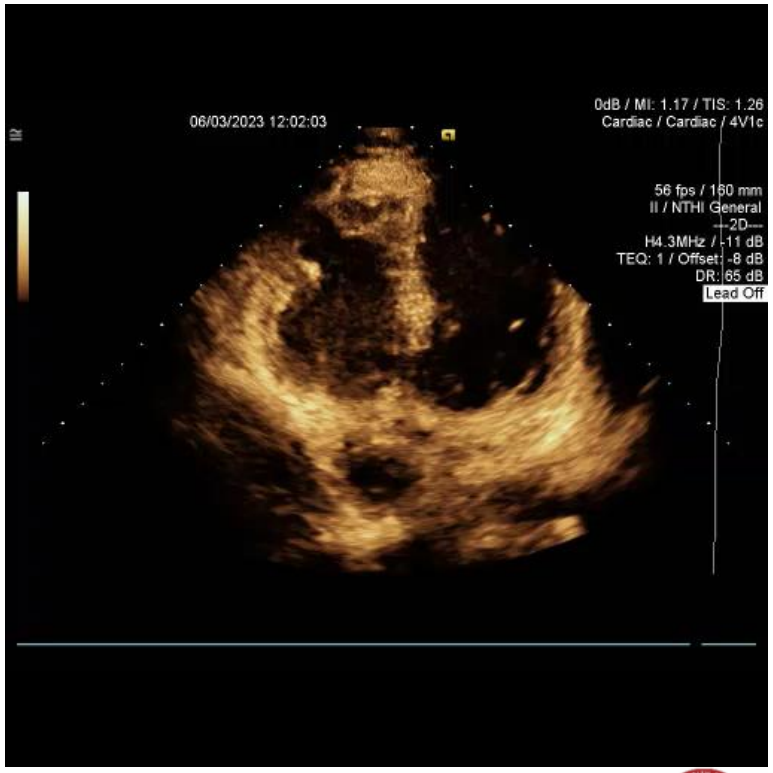


Kontrolné TTE

- CUS – trombóza vv. Tibiales posterior
- DOAK
- TTE: S´ 13,7 cm/s, RV/LV 1,12 (1,84) = ↓60%



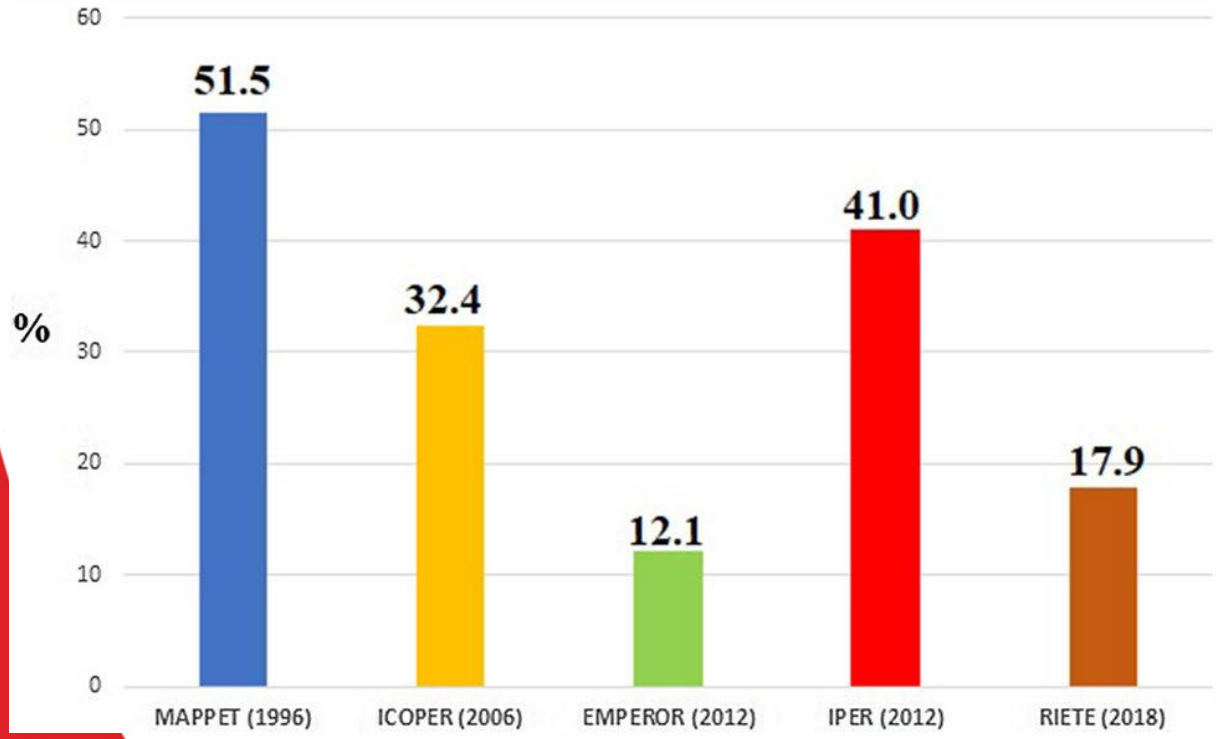




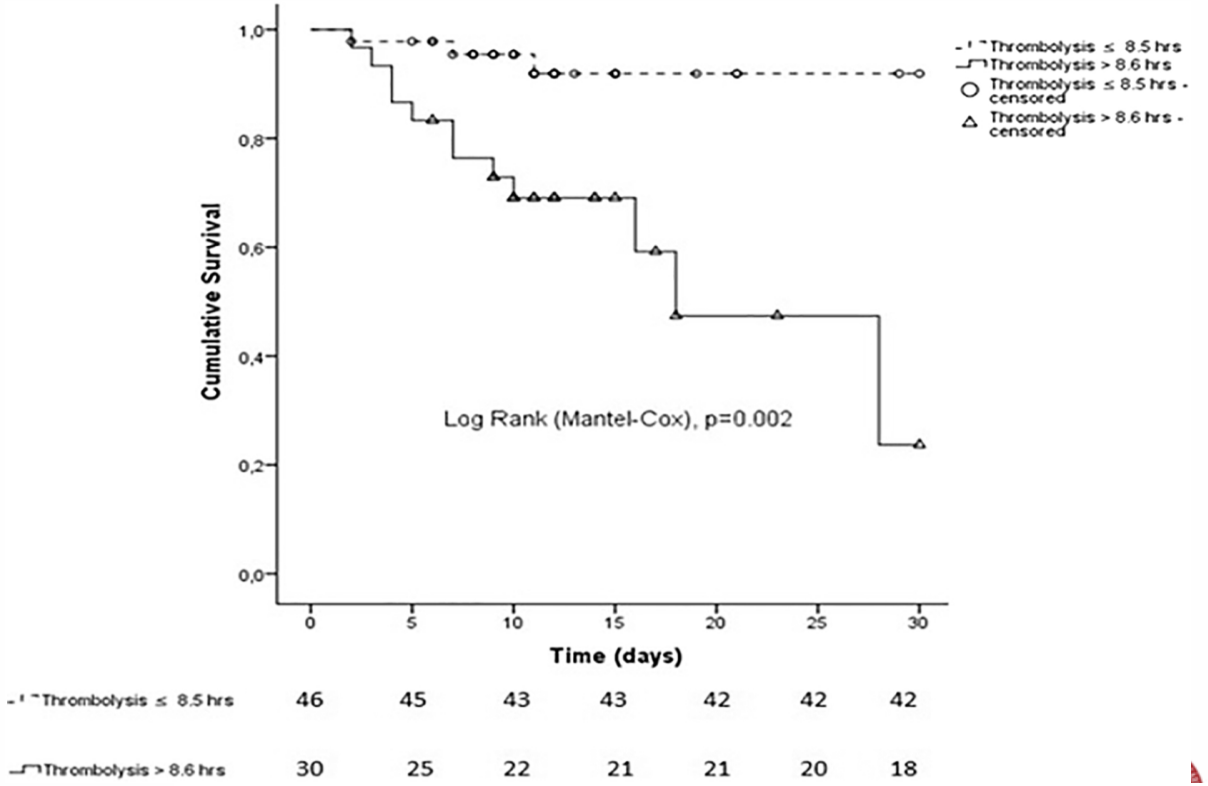
Východoslovenský ústav srdcových a cievnych chorôb, a.s.

Systémová trombolýza

- TLL je stáde podužívaná a odpoveď na liečbu klesá s dĺžkou trvania sypmtómov
- Podanie po 8,5 hodinách vs. do 8,5 hod. bolo spojené s vyššou 30 dňovou KV mortalitou (HR 7,81; 95%CI 1,84-33,05, p=0,005) a incidenciou závažného krvácania (40% vs. 6,5%, p<0,001) a klinickým zhoršením stavu (23,3% vs. 6,5%; p=0,03)



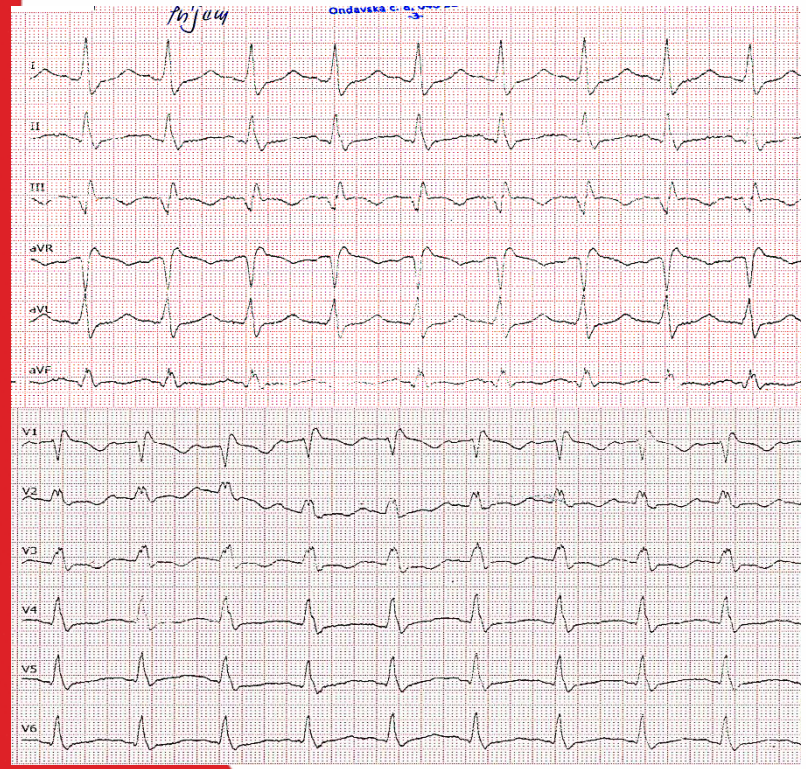
Zuin et al., J Thromb Thrombolysis 2019:48(2):323-330

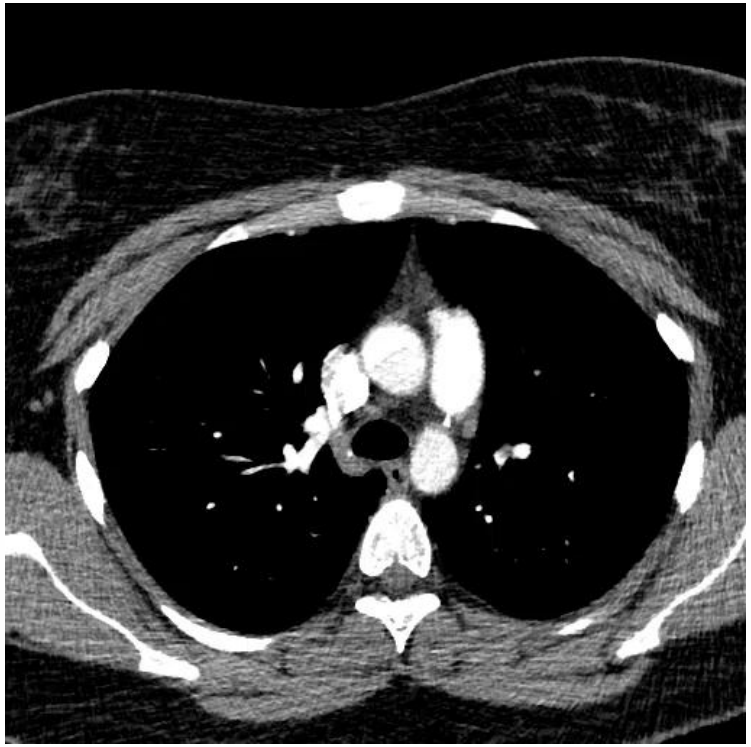


Zuin et al., Thromb Res 2019;173:117-123.

Kazuistika 5

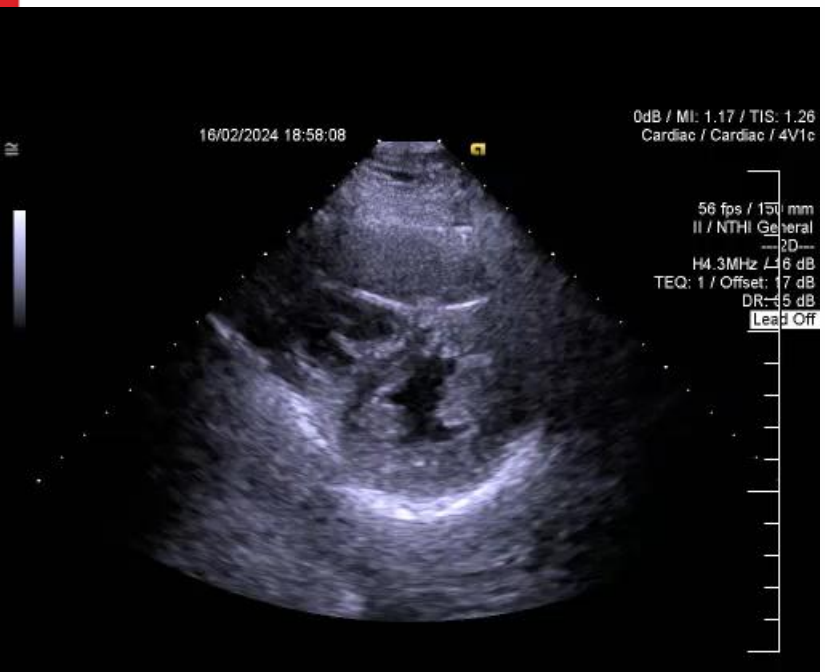
- 20 ročná pacientka, synkopa (20s bezvedomie), TK 150/90 mmHg, SF 160/min, SpO2: 92%, Užívanie HAK, RR 21/min
- CT-PA – masívna PE, dilatácia PK, sedlovitý trombus
- sPESI 1, PESI 40b – tr. I !!!
- ESC – Intermediate High risk, ACC/AHA – D2 R-
- Hs-TNI 939,3 ng/l, NTproBNP 215 pg/ml, A-Lakt 2,1 mmol/l

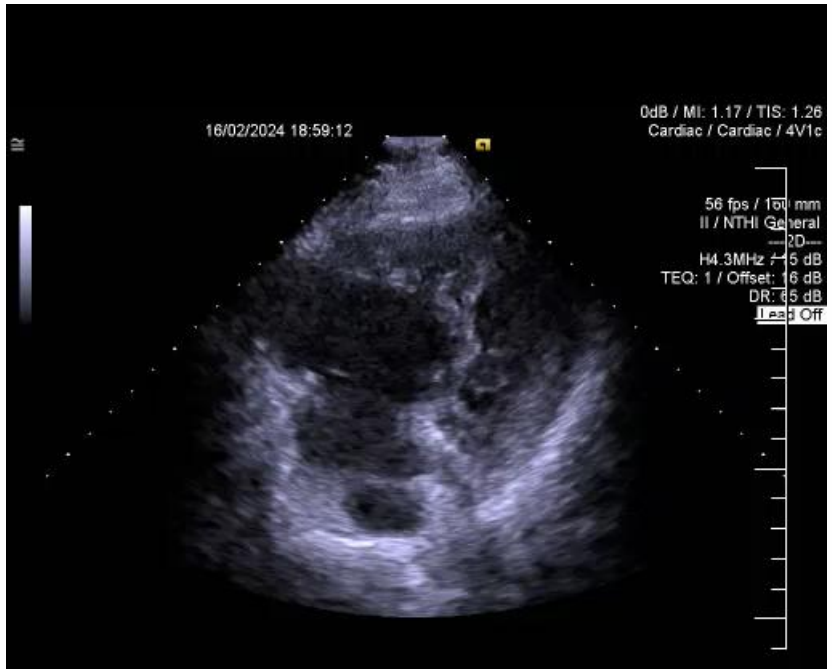


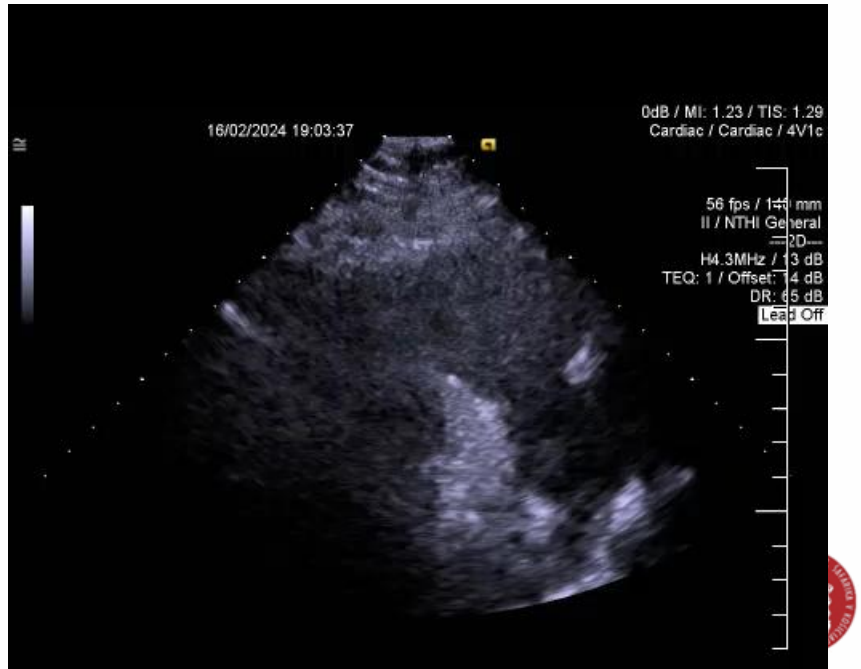


Kazuistika

- TTE – dilatácia PK (RVD1 49mm) + dysfunkcia, RV/LV 1,45
- NEWS Skóre – 9 (RR 2b, SF 3b, potreba O2 2b, SpO2 2b)
- CPES skóre - 6
- PERT tím – absencia kontraindikácií - podanie TLL

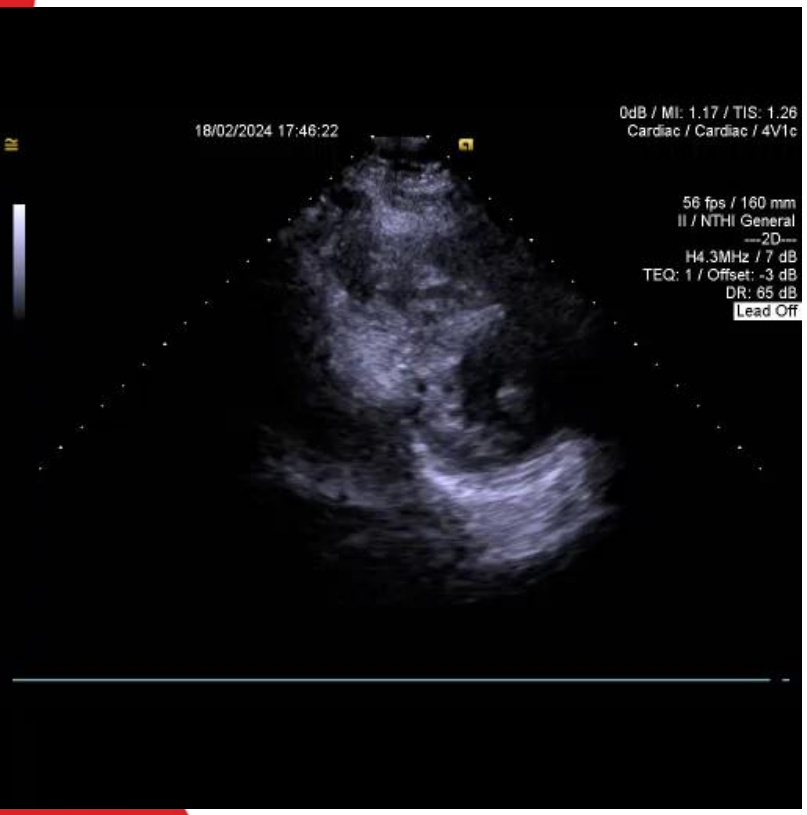


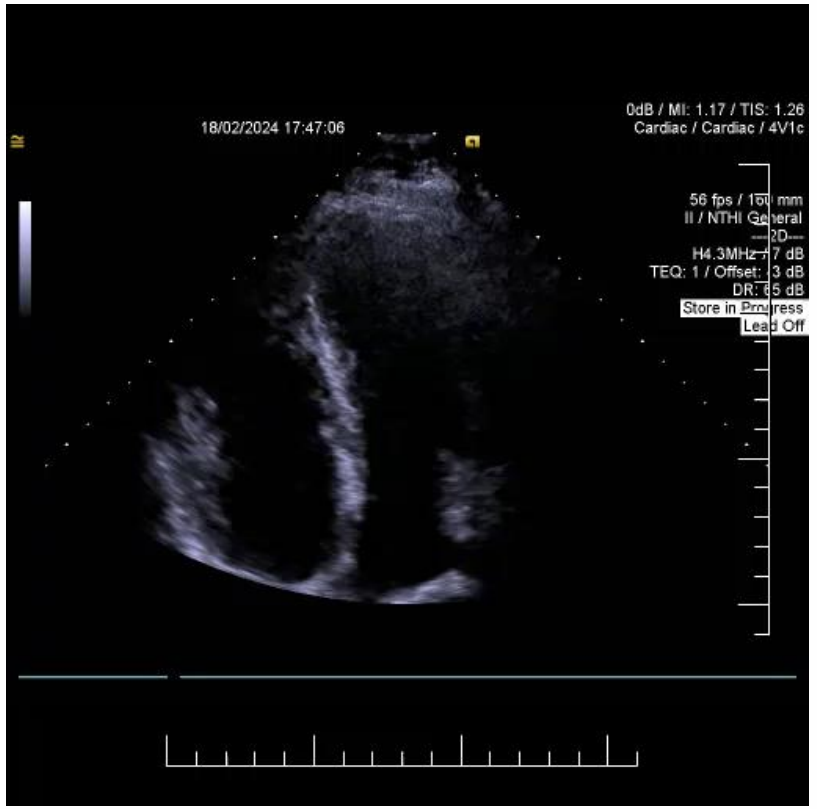


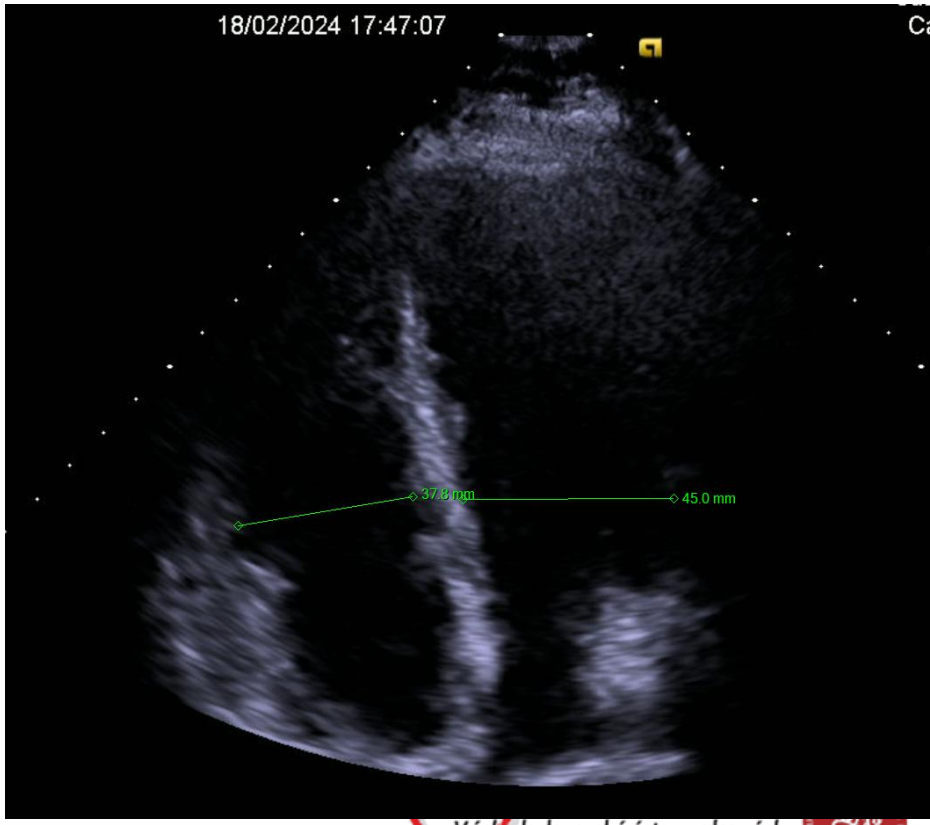


TTE kontrola

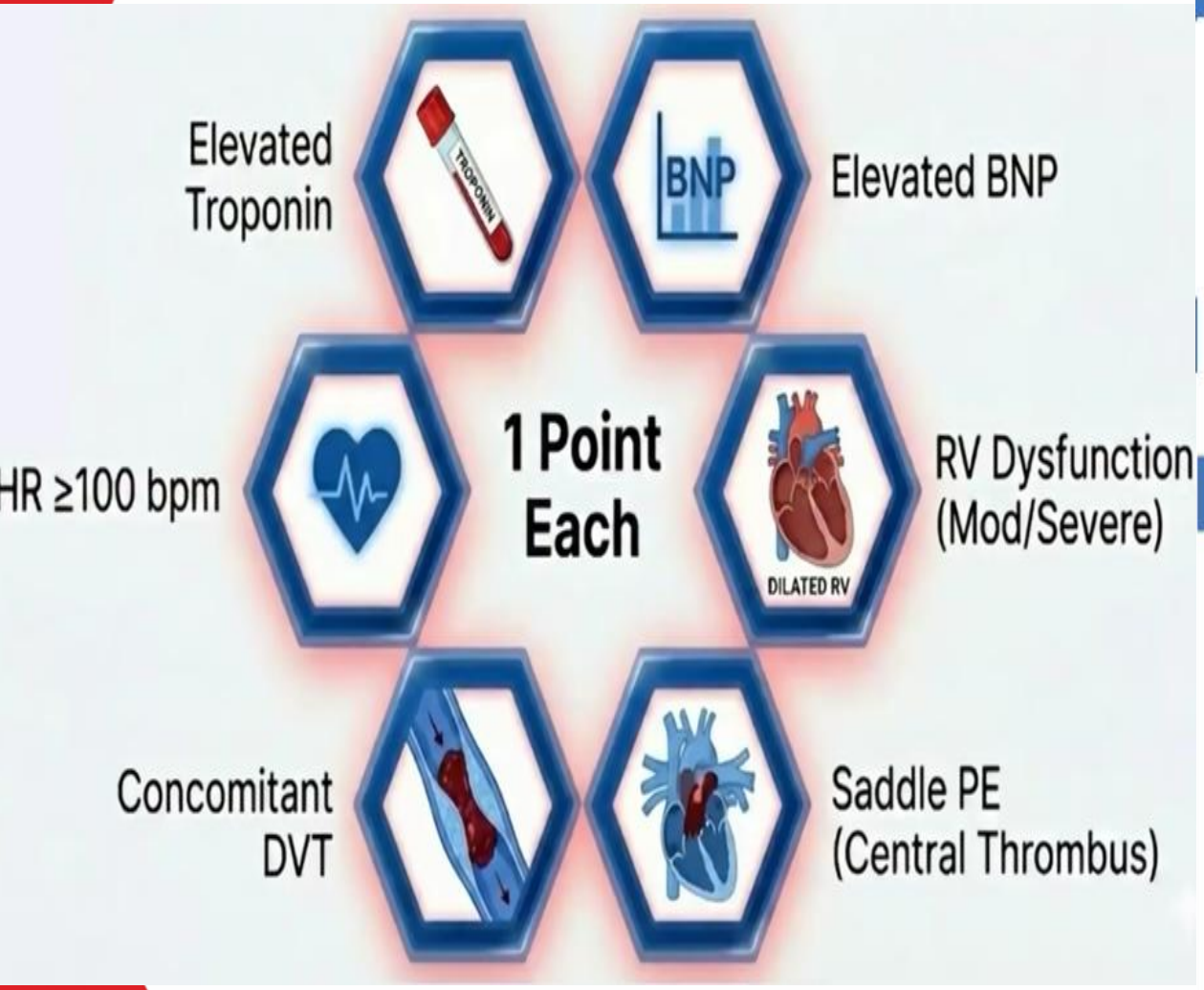
- CUS – trombóza vv. Tibiales posterior
- DOAK
- TAPSE 19mm, S´ 13,1cm/s , RV/LV 0,84 (1,45) = ↓43%

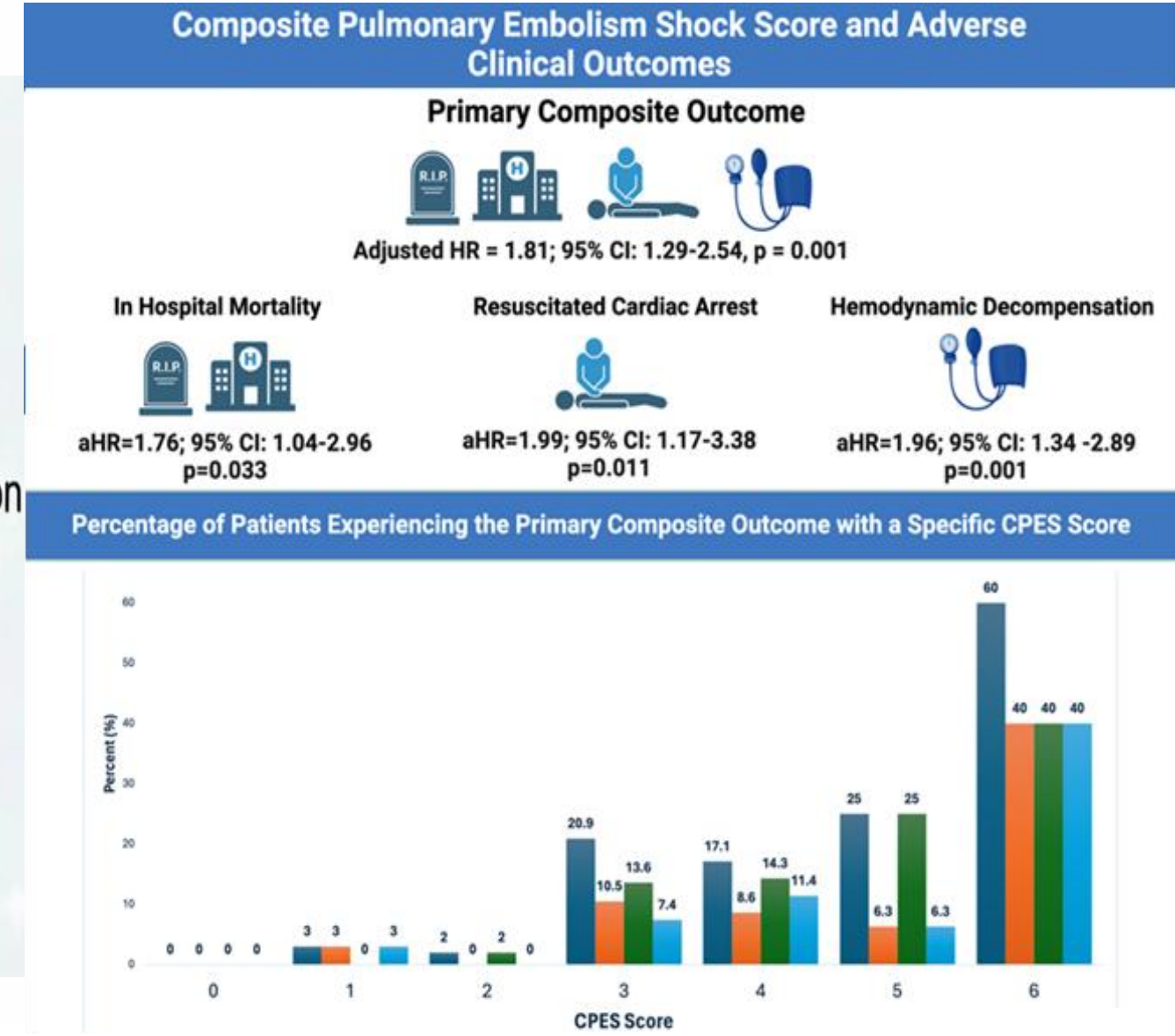




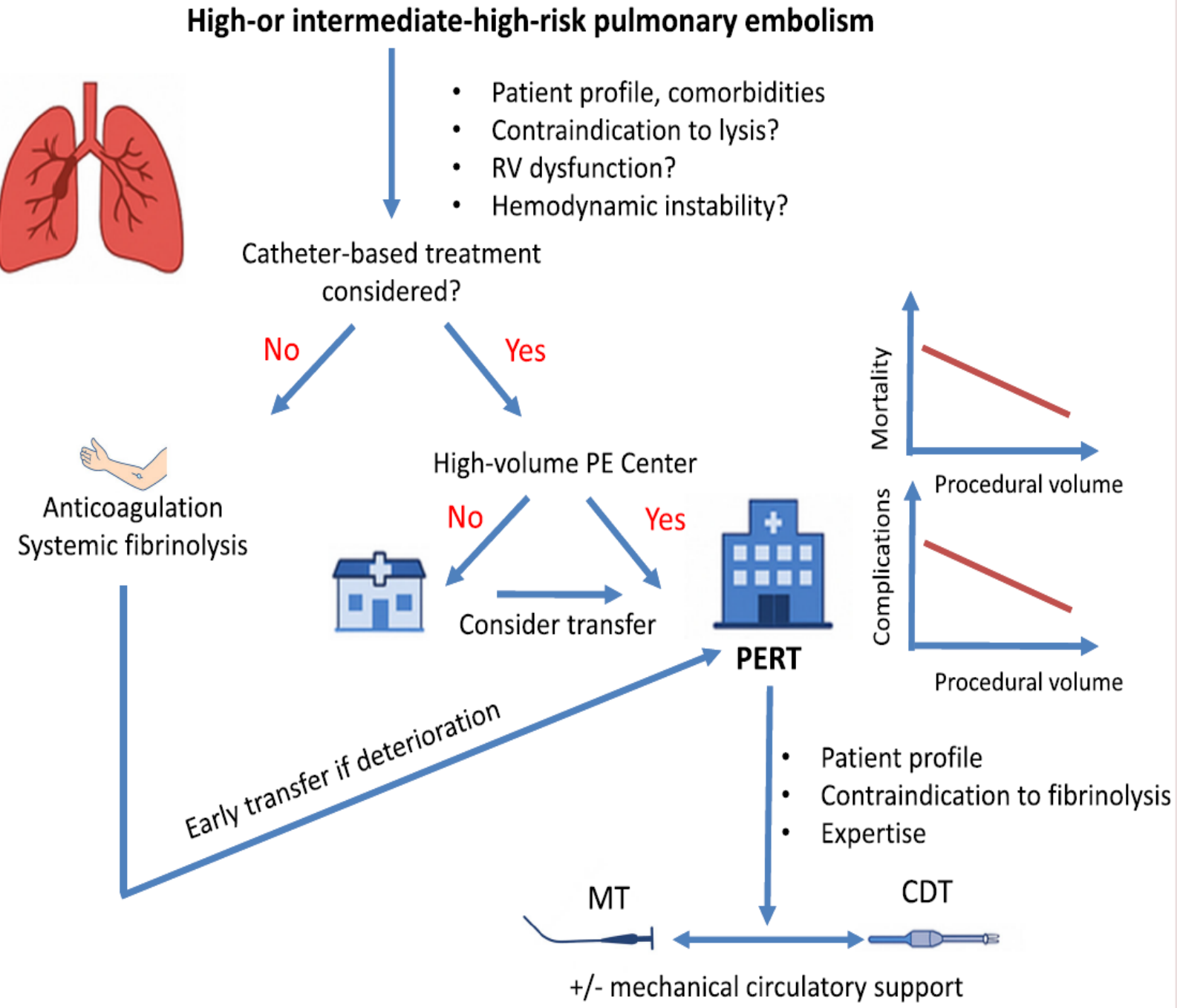


CPES skóre





Zhang et al., Circ Cardiovasc Interv 2024; 17(8):e014088



Glauser, Roffi, EHJ ACC 2025;14:720-722

Recommendations for Interhospital Transfers
Referenced studies that support recommendations are summarized in the Evidence Table.

COR	LOE	RECOMMENDATIONS
2b	C-LD	1. For patients with acute PE who exhibit high-risk features* but are hemodynamically stable (AHA/ACC PE Categories C3-D), transferring to a center that can provide advanced therapies† may be considered to ensure access to appropriate interventions.[1]
3: Harm	C-EO	2. Unstable patients with acute PE (AHA/ACC PE Category E) should not be transferred to another medical center before stabilizing their condition.

*High-risk features include RV dysfunction and elevated cardiac biomarkers. †Advanced therapy examples: surgical embolectomy, CDL, MT, ECMO, and placement of an IVC filter.

Recommendation for PERT
Referenced studies that support the recommendation are summarized in the Evidence Table.

COR	LOE	RECOMMENDATIONS
1	B-NR	1. In patients with acute PE who are at increased risk of adverse outcomes (ie, AHA/ACC PE Categories C-E)*, a multidisciplinary PERT assessment is recommended to improve in-hospital clinical care delivery.[1-18]

*AHA/ACC PE Categories A or B with multiple comorbidities may also benefit from a PERT (eg, Category B with intracranial hemorrhage).

Creager et al., JACC 2026; 87(13):1626-1710

Záver

- Trombolýza ostáva zlatým štandardom pri high risk pľúcnej embólii, je efekt klesá s časom od nástupu symptómov.
- Voľba reperfúznej stratégie musí byť individuálna, rozhoduje anatómia, kontraindikácie a komorobidity.
- ECMO má skôr význam ako most k reperfúzii, nie ako destinačná liečba.
- PERT tím má najväčší význam v komplexných a hraničných prípadoch a v komunikácii so spádovými nemocnicami.