ΠΑΝΕΠΙΣΤΗΜΙΟ ΙΩΑΝΝΙΝΩΝ

ΠΝΕΥΜΟΝΙΚΗ ΕΜΒΟΛΗ ΚΑΙ ΝΕΟΤΕΡΑ ΔΕΔΟΜΕΝΑ-Ο ΡΟΛΟΣ ΤΟΥ ΥΠΕΡΗΧΟΥ

Αλέξανδρος Κουρτίνος
Ειδικευόμενος
Χρήστος Κατσούρας
Αναπληρωτής Καθηγητής

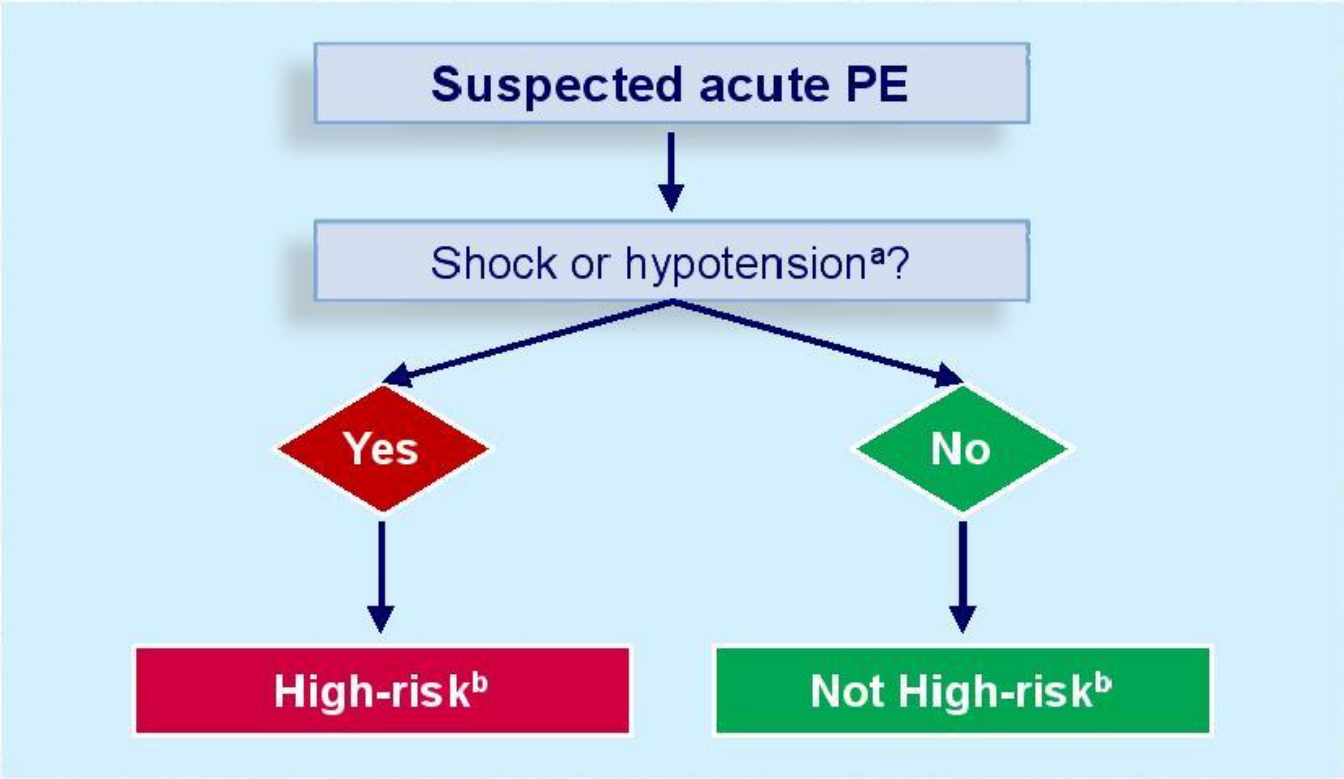
Σημαντικά δεδομένα Π.Ε

- Υψηλή νοσηρότητα
- Υψηλή θνητότητα
- Συχνή υπερδιάγνωση και θεράπεια
- Ανάγκη επιθετικής θεραπείας

ΕΝΟΤΗΤΕΣ

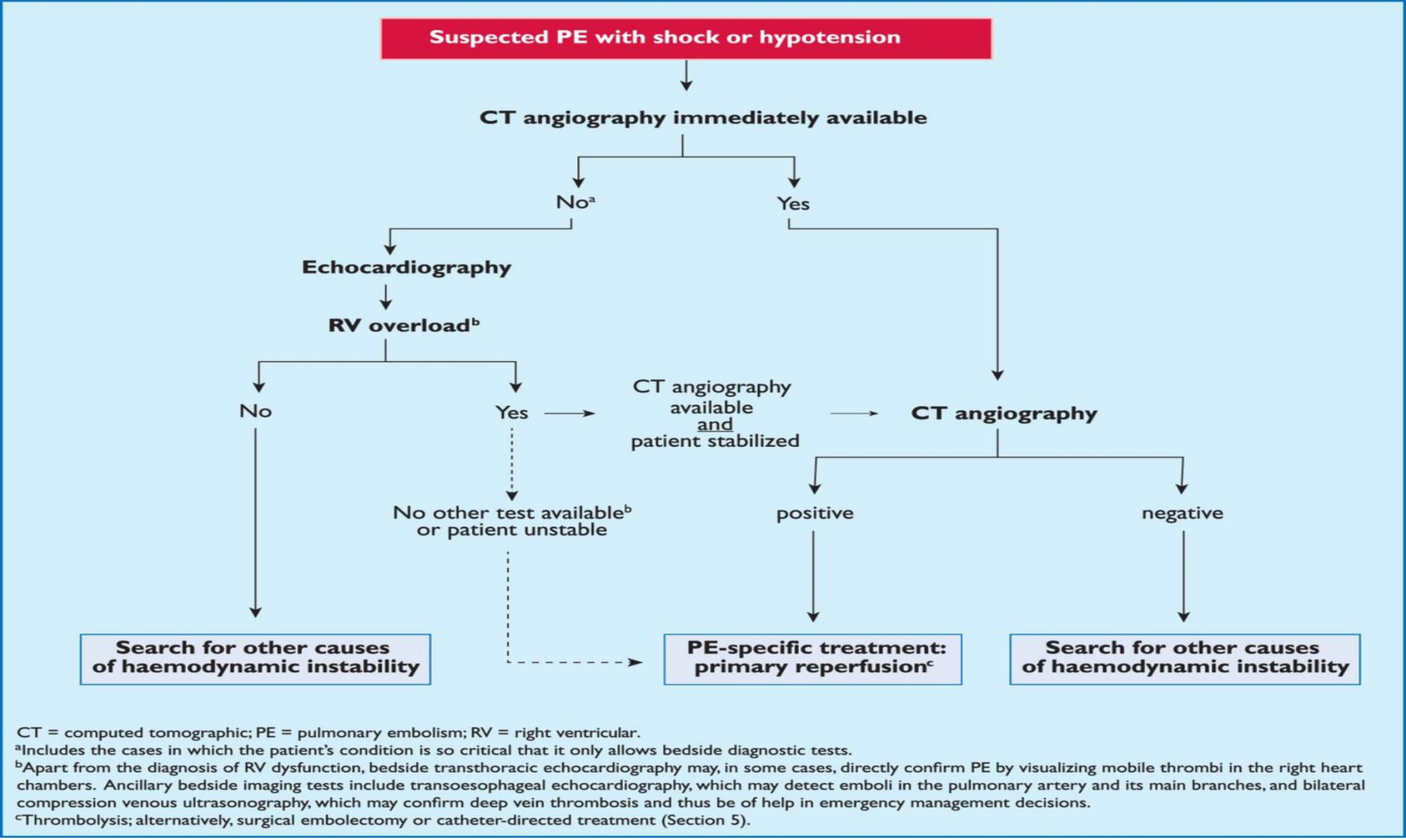
1. Αλγόριθμος διάγνωσης Π.Ε
2. Ρόλος του υπερήχου στη διάγνωση
3. Ρόλος του υπερήχου στη διαστρωμάτωση κινδύνου

Initial risk stratification of acute PE



[a] Defined as systolic blood pressure <90 mmHg, or a systolic pressure drop by ≥40 mmHg, for >15 minutes, if not caused by new-onset arrhythmia, hypovolaemia, or sepsis.
[b] Based on the estimated PE-related in-hospital or 30-day mortality.

European Heart Journal (2014):doi:10.1093/eurheartj/ehu283



CT = computed tomographic; PE = pulmonary embolism; RV = right ventricular.
[a]Includes the cases in which the patient's condition is so critical that it only allows bedside diagnostic tests.
[b]Apart from the diagnosis of RV dysfunction, bedside transthoracic echocardiography may, in some cases, directly confirm PE by visualizing mobile thrombi in the right heart chambers. Ancillary bedside imaging tests include transoesophageal echocardiography, which may detect emboli in the pulmonary artery and its main branches, and bilateral compression venous ultrasonography, which may confirm deep vein thrombosis and thus be of help in emergency management decisions.
[c]Thrombolysis; alternatively, surgical embolectomy or catheter-directed treatment (Section 5).

From: 2014 ESC Guidelines on the diagnosis and management of acute pulmonary embolismThe Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC)Endorsed by the European Respiratory Society (ERS)

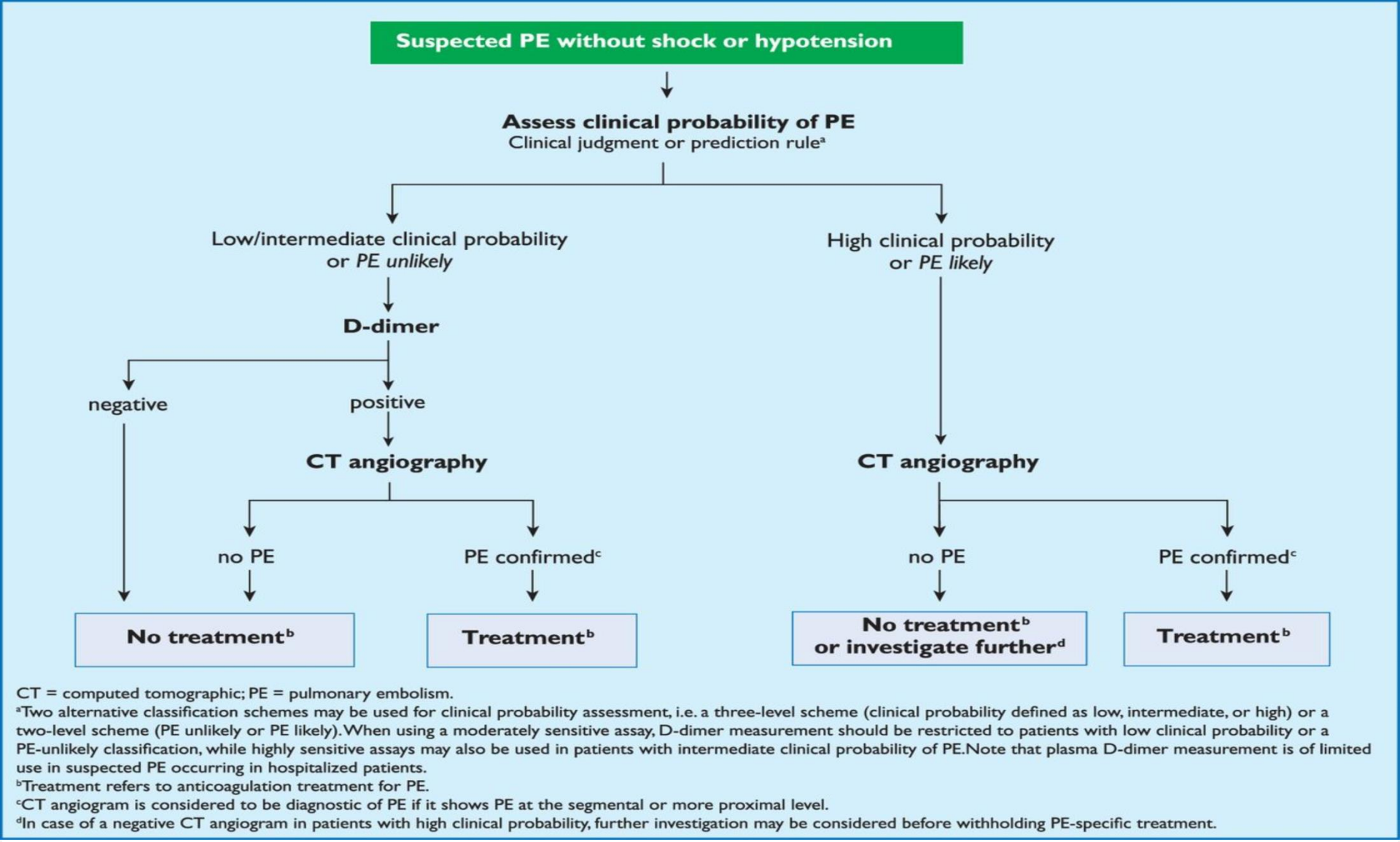
Eur Heart J. 2014;35(43):3033-3073. doi:10.1093/eurheartj/ehu283

Υπολογισμός πιθανότητας Π.Ε σε μη υψηλού κινδύνου ασθενείς

Wells score	
Variable	**Points**
Previous DVT or PE	1.5
Recent surgery or immobilization	1.5
Cancer	1
Hemoptysis	1
Heart rate >100 beats/min	1.5
Clinical signs of DVT	3
Alternative diagnosis less likely than PE	3
Clinical probability (3 levels)	Total
Low	0–1
Intermediate	2–6
High	≥7
Clinical probability (2 levels)	
PE unlikely	0–4
PE likely	>4

Revised Geneva score	
Variable	**Points**
Age >65 years	1
Previous DVT or PE	3
Surgery or fracture within 1-month	2
Active malignancy	2
Unilateral lower limb pain	3
Hemoptysis	2
Heart rate 75–94 beats/min	3
Heart rate ≥95 beats/min	5
Pain on lower limb deep vein at palpation and unilateral edema	4
Clinical probability (3 levels)	Total
Low	0–3
Intermediate	4–10
High	≥11
Clinical probability (2 levels)	
PE unlikely	0–3
PE likely	>3

DVT: Deep vein thrombosis; PE: Pulmonary embolism.



CT = computed tomographic; PE = pulmonary embolism.

[a]Two alternative classification schemes may be used for clinical probability assessment, i.e. a three-level scheme (clinical probability defined as low, intermediate, or high) or a two-level scheme (PE unlikely or PE likely). When using a moderately sensitive assay, D-dimer measurement should be restricted to patients with low clinical probability or a PE-unlikely classification, while highly sensitive assays may also be used in patients with intermediate clinical probability of PE. Note that plasma D-dimer measurement is of limited use in suspected PE occurring in hospitalized patients.

[b]Treatment refers to anticoagulation treatment for PE.

[c]CT angiogram is considered to be diagnostic of PE if it shows PE at the segmental or more proximal level.

[d]In case of a negative CT angiogram in patients with high clinical probability, further investigation may be considered before withholding PE-specific treatment.

From: 2014 ESC Guidelines on the diagnosis and management of acute pulmonary embolismThe Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC)Endorsed by the European Respiratory Society (ERS)

Eur Heart J. 2014;35(43):3033-3073. doi:10.1093/eurheartj/ehu283

JAMA 2018 Feb 13; 319(6): 559–566.
Published online 2018 Feb

Effect of the Pulmonary Embolism Rule-Out Criteria on Subsequent Thromboembolic Events Among Low-Risk Emergency Department Patients

The PROPER Randomized Clinical Trial

PERC Rule

- Age less than 50
- Pulse less than 100 bpm
- Hypoxaemia (Pulse Ox > 95%)
- No past history of DVT or PE
- No recent trauma or surgery
- No haemoptysis
- No exogenous estrogen
- No unilateral leg swelling

Derived from 3148 patients. Kline JA et al. J Thromb Haemostasis. 2004.

Δυνατότητα χρήσης PERC Rule για αποκλεισμό Π.Ε

- Μελέτη μη κατωτερότητας
- Ασθενείς χαμηλού κινδύνου
- Αποκλεισμός **κλινικά σημαντικής** θρόμβωσης

Diagnostic tests and pathways: not high-risk PE

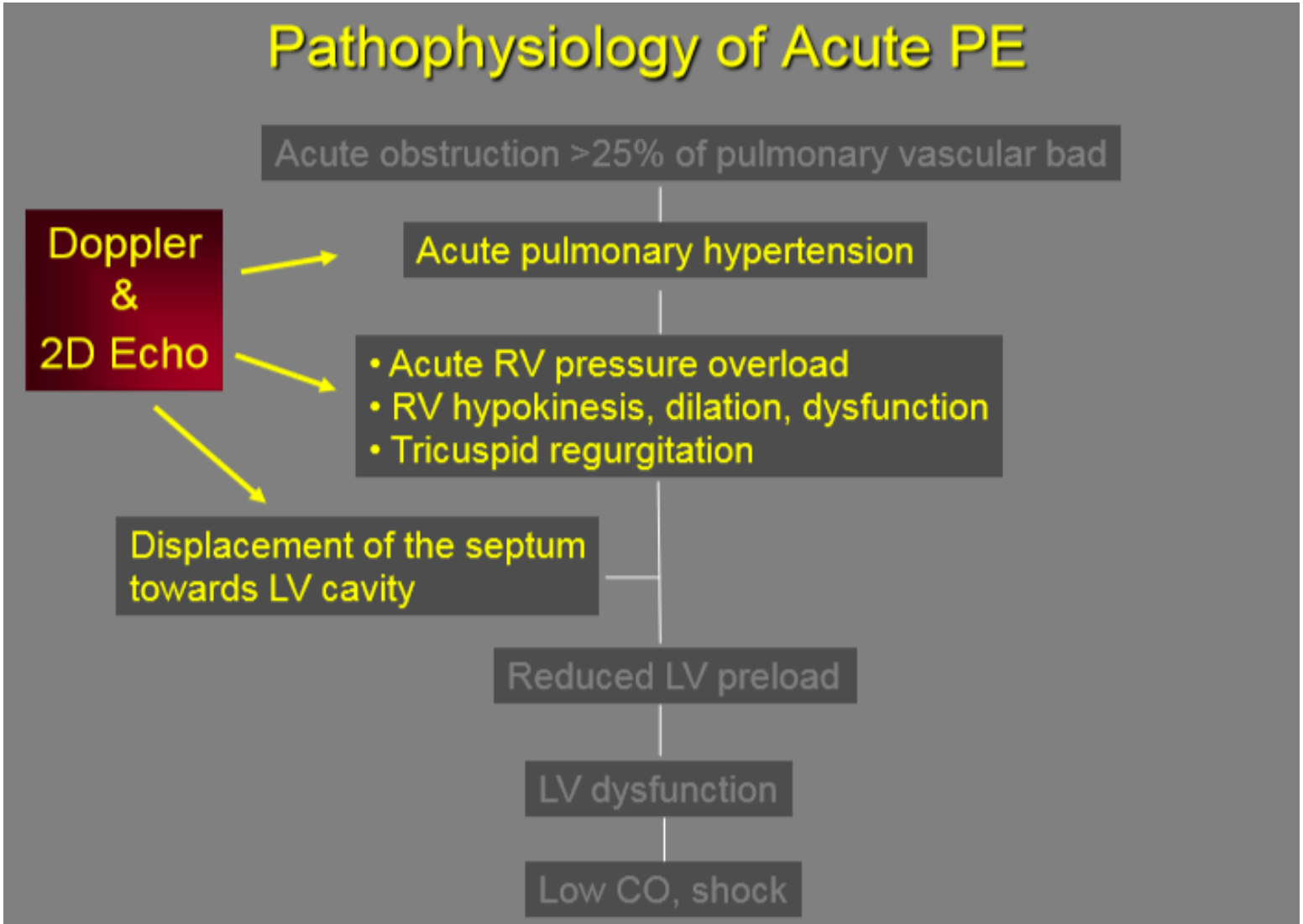
Diagnostic criterion	Clinical probability of PE				
	Low	Intermediate	High	PE unlikely	PE likely
Exclusion of PE					
D-Dimer					
Negative result, highly sensitive assay	+	+	–	+	–
Negative result, moderately sensitive assay	+	±	–	+	–
Chest CT angiography					
Normal multidetector CT alone	+	+	±	+	±
V/Q scan					
Normal perfusion lung scan	+	+	+	+	+
Non-diagnostic lung scan and negative proximal CUS	+	±	–	+	–
Confirmation of PE					
Chest CT angiogram showing at least segmental PE	+	+	+	+	+
High probability V/Q scan	+	+	+	+	+
CUS showing proximal DVT	+	+	+	+	+

European Heart Journal (2014):doi:10.1093/eurheartj/ehu283

Υπέρηχος ΜΟΝΟ για διαστρωμάτωση κινδύνου

Early mortality risk		Risk parameters and scores			
		Shock or hypotension	PESI class III-V or sPESI ≥1[a]	Signs of RV dysfunction on an imaging test[b]	Cardiac laboratory biomarkers[c]
High		+	(+)[d]	+	(+)[d]
Intermediate	Intermediate–high	-	+	Both positive	
	Intermediate–low	-	+	Either one (or none) positive[e]	
Low		-	-	Assessment optional; if assessed, both negative[e]	

Υπέρηχος και διάγνωση Π.Ε

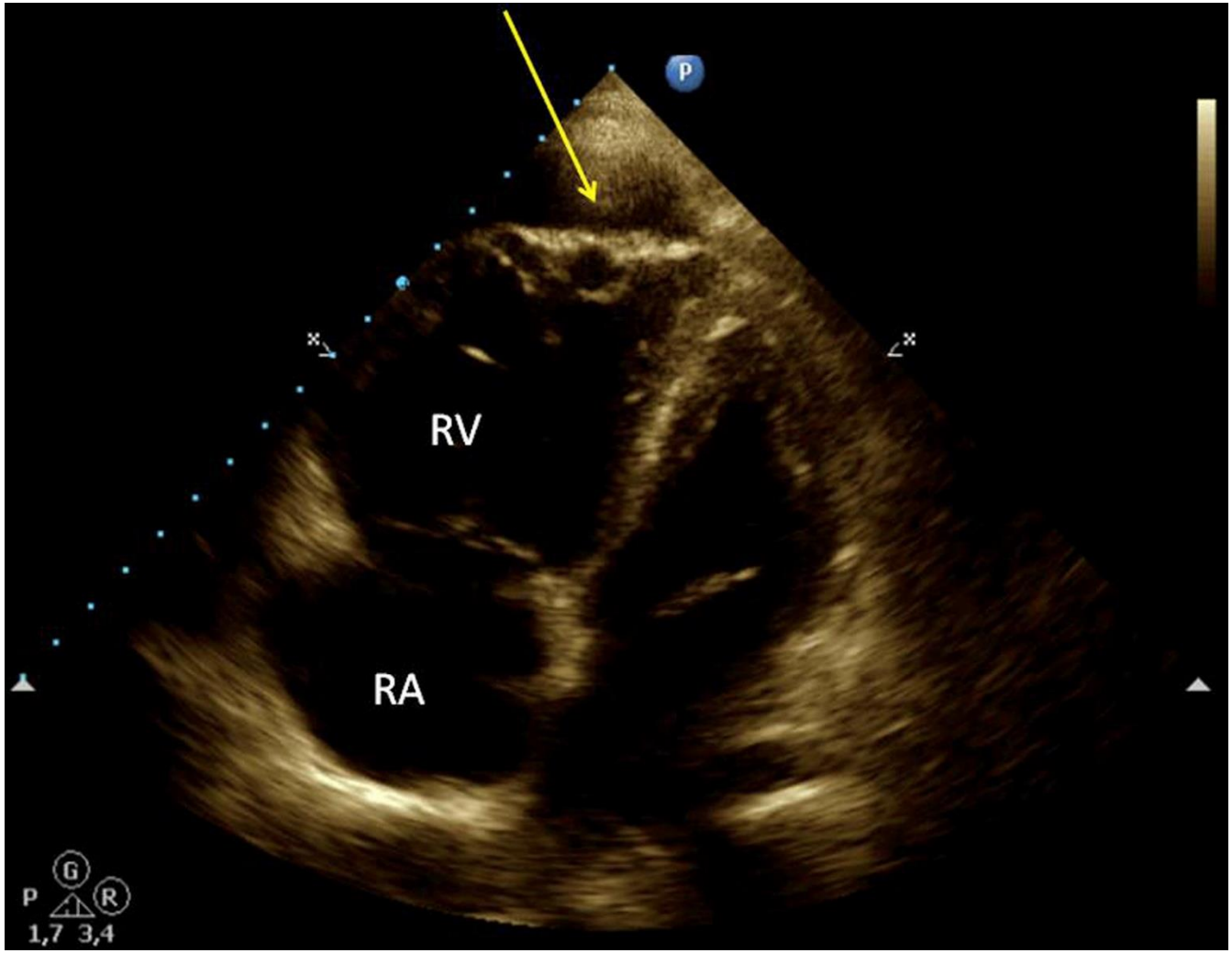


Echo Signs of PE

- RV dilatation/hypokinesis and subsequent TR
- RA dilation
- Dilation of PA and its branches
- Dilated (>20mm), non-collapsing (insp) IVC
- Flattened interventricular septum
- Decreased LV size
- Increased RV/LV end-diastolic diameter ratio
- TR jet >2.5 m/s (mild-moderate PA hypertension)
- RVOT mid-systolic "notching" pattern (AcT<80 ms, with mid-systolic deceler)

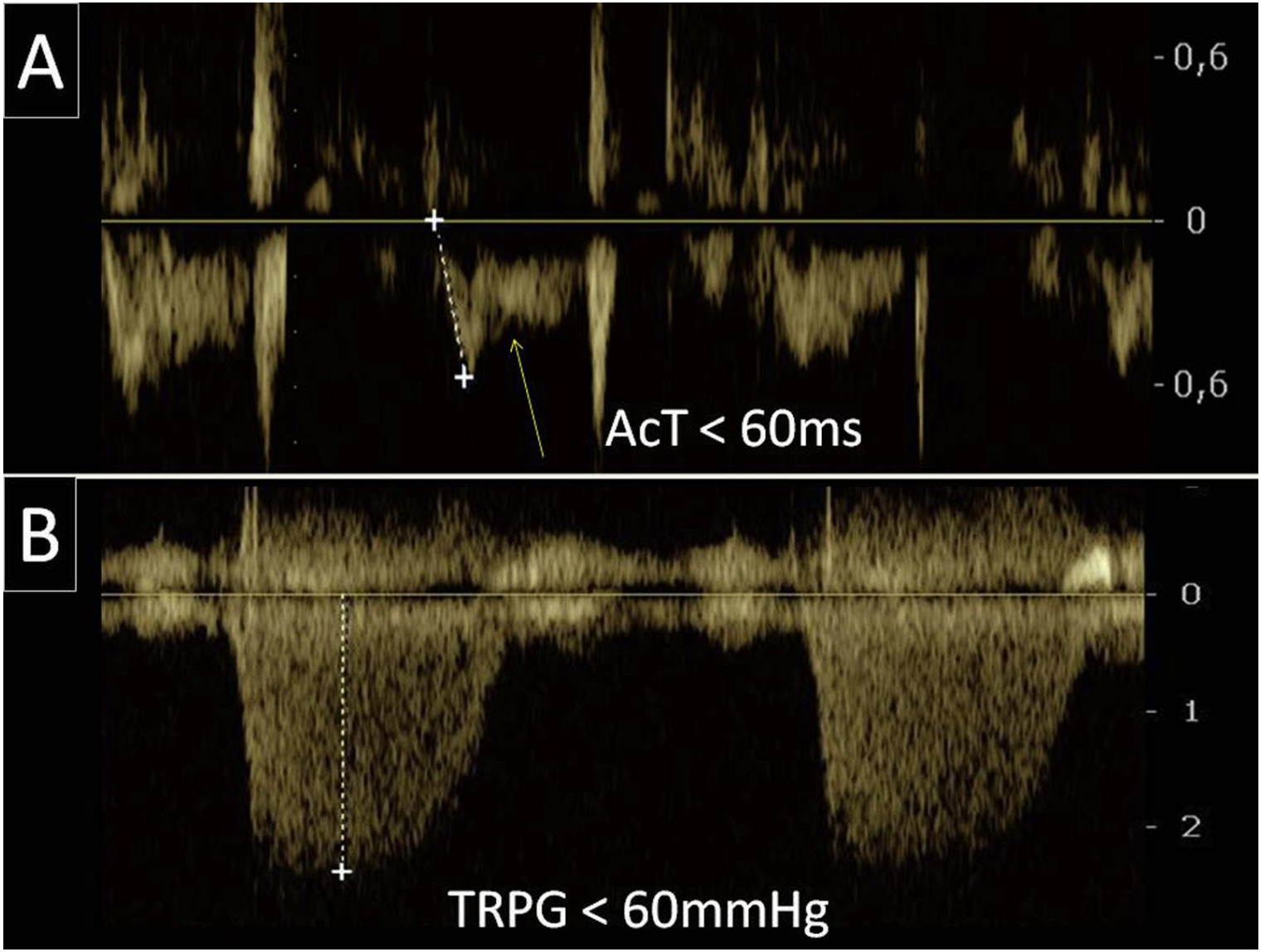
- Direct thrombus visualization in the right heart or PA

The McConnell sign. Hypokinesis of right ventricular free wall with a normal contraction of the apical segment *(arrow)*. *RA*, Right atrium; *RV*, right ventricle.

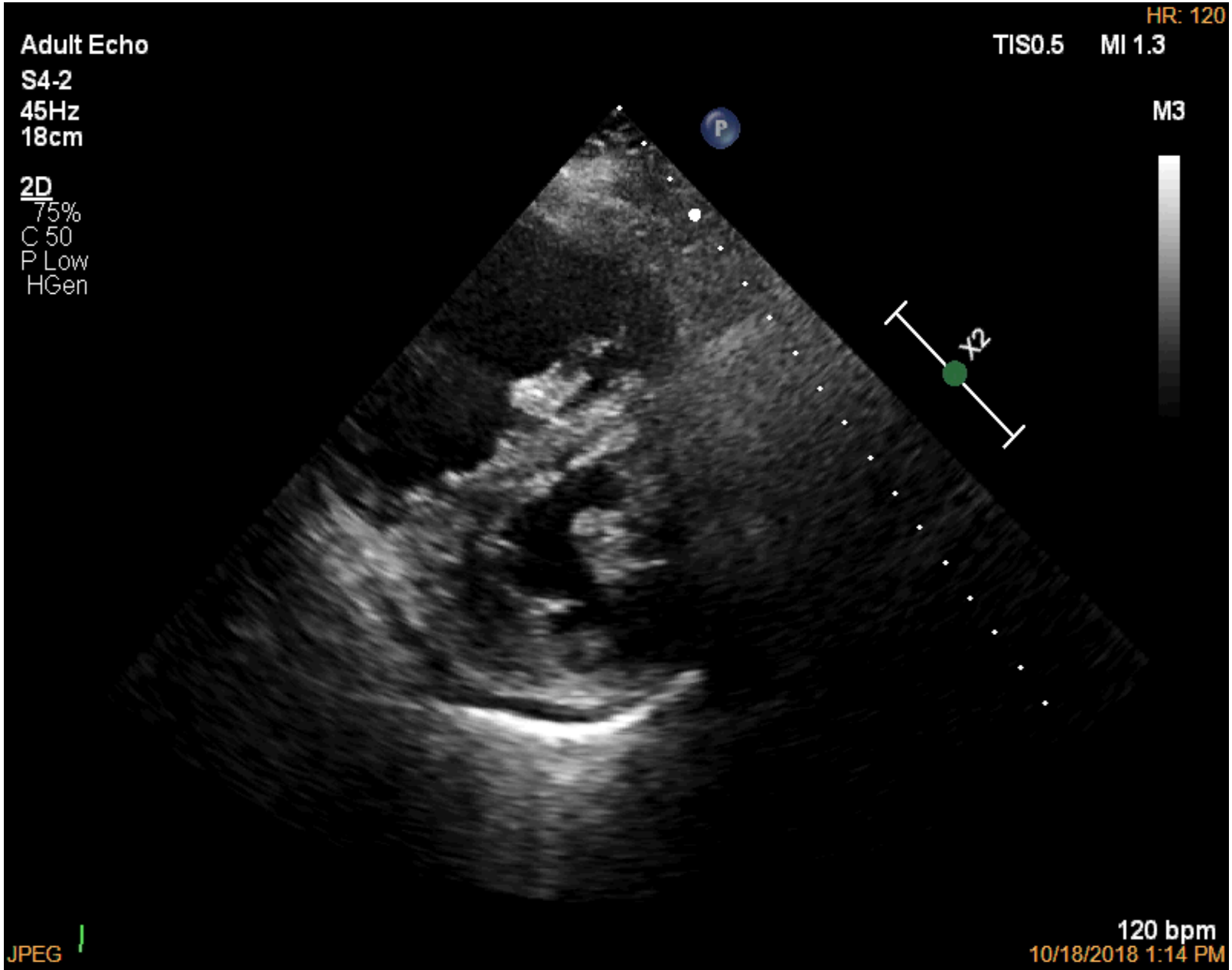


The McConnell sign. Hypokinesis of right ventricular free wall with a normal contraction of the apical segment *(arrow)*. *RA*, Right atrium; *RV*, right ventricle.

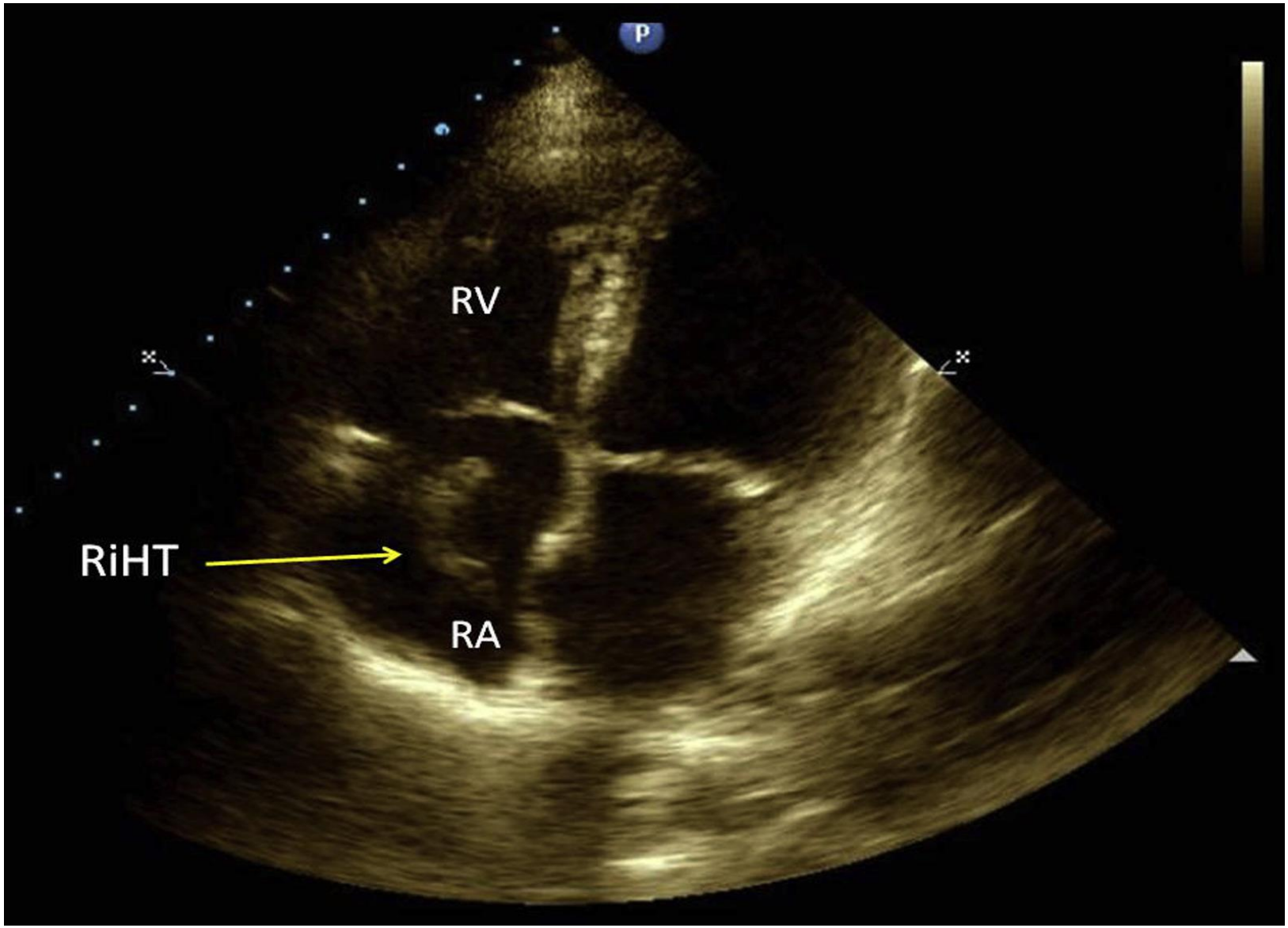
The 60/60 sign. Coexistence of shortened AcT < 60 msec **(A)** with midsystolic notch *(arrow)* and of TRPG < 60 mm Hg **(B)**.



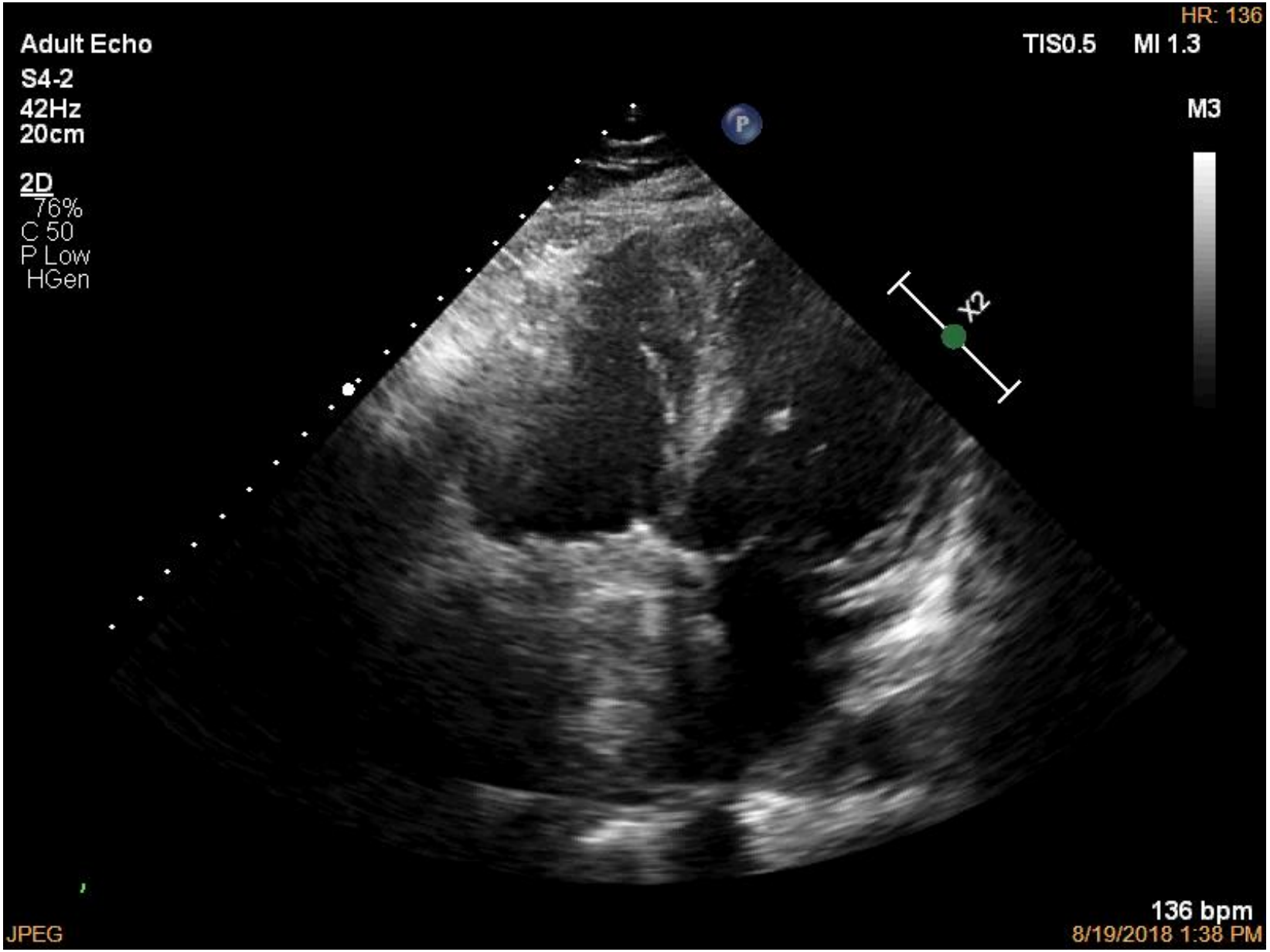
D shape LV


HR: 120
Adult Echo
S4-2
45Hz
18cm
2D
75%
C 50
P Low
HGen
TIS0.5
MI 1.3
M3
P
X2
120 bpm
10/18/2018 1:14 PM
JPEG

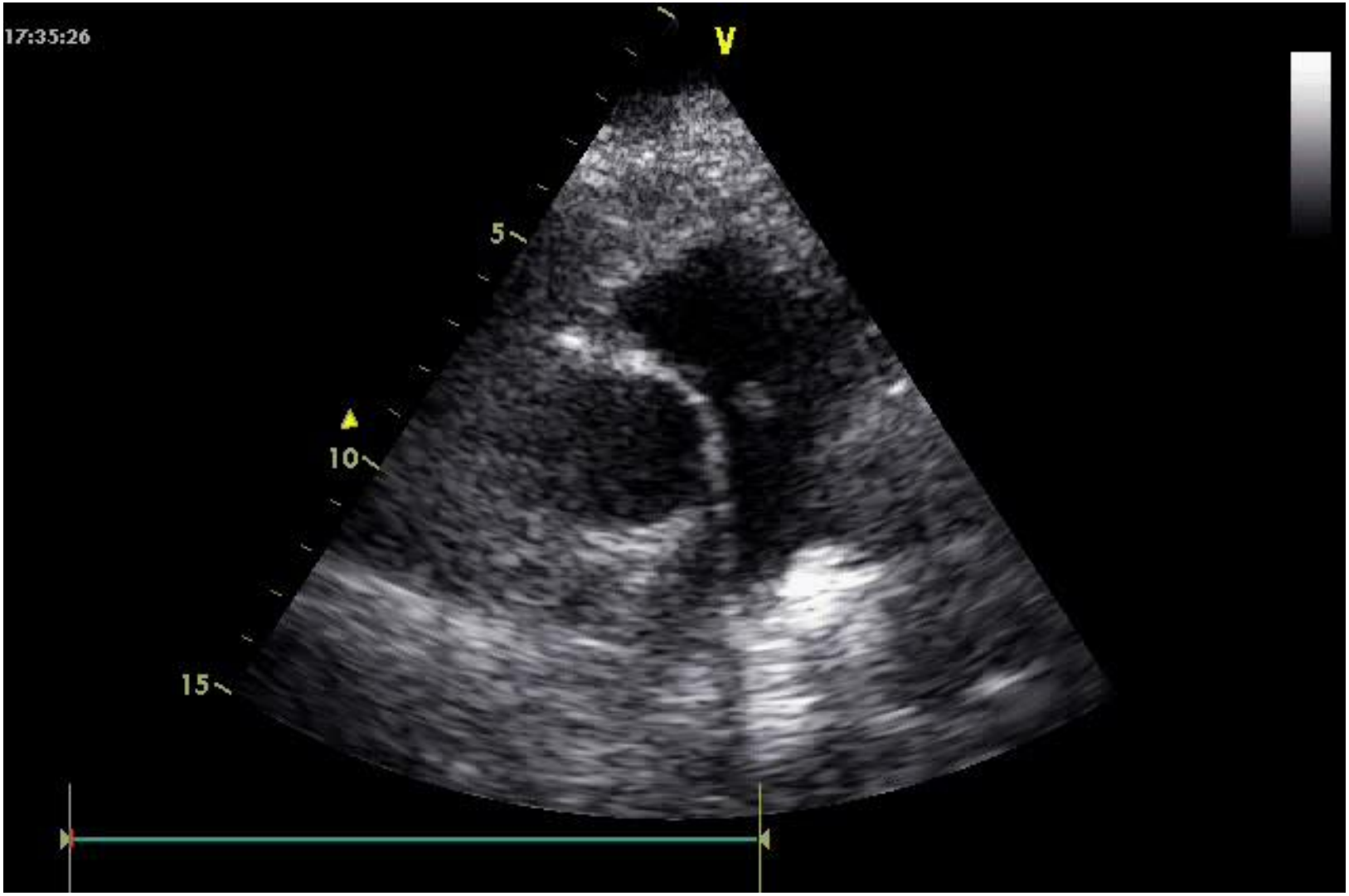
Right heart thrombus (RiHT) *(arrow)*. *RA*, Right atrium; *RV*, right ventricle.



Right heart thrombus



Thrombus in pulmonary artery



Pooled test characteristics of echocardiographic signs of pulmonary embolism.

Sign	N	Sensitivity (95% CI), %	Specificity (95% CI), %	LR+ (95% CI)	LR− (95% CI)
McConnell's sign	571	22 (16–29)	97 (95–99)	8.5 (4.4–16.5)	0.8 (0.7–0.9)
Paradoxic septal motion	925	26 (22–31)	95 (93–97)	5.1 (3.6–7.6)	0.8 (0.7–0.8)
Elevated RV end-diastolic diameter	473	80 (61–92)	80 (67–89)	4.5 (3.5–5.9)	0.3 (0.2–0.3)
RV hypokinesis	627	38 (31–44)	91 (88–94)	4.2 (3.0–6.0)	0.7 (0.6–0.8)
Abnormal RV:LV ratio	879	55 (49–60)	86 (83–89)	3.9 (3.1–4.8)	0.5 (0.5–0.6)
Right-sided heart strain	1,986	53 (45–61)	83 (74–90)	3.4 (2.9–4.0)	0.6 (0.5–0.6)

CI, Confidence interval; *LR+*, positive likelihood ratio; *LR−*, negative likelihood ratio; *RV*, right ventricle; *LV*, left ventricle.

Can Echocardiography Be Used to Diagnose Pulmonary Embolism at the Bedside? Ehrman RR[1], Favot MJ[1]. Ann Emerg Med. **2018 Sep;72(3):310-311. doi: 10.1016/j.annemergmed.2017.09.018. Epub 2017 Nov 3.**

Table 2

Echocardiographic parameters of 511 patients with confirmed PE according to the severity of PE

Parameter	All PE (*n* = 511)	High-risk PE (*n* = 16)	*P*	Non-high-risk PE (*n* = 495)
LV dimension (mm)	41.5 ± 6.8	38.1 ± 11.0	.19	41.6 ± 6.5
RV dimension (mm)	38.3 ± 8.1	45.0 ± 8.3	**.004**	38.0 ± 8.0
RV/LV	0.94 ± 0.3	1.3 ± 0.4	**.003**	0.92 ± 0.3
TRPG (mmHg)	34.4 ± 16.4	49.2 ± 22.3	**.02**	33.9 ± 16.0
AcT (msec)	87.4 ± 28.8	60.6 ± 12.6	**<.0001**	88.3 ± 28.8
TAPSE (mm)	21.2 ± 5.8	16.5 ± 4.9	.40	21.3 ± 5.8
Flattened IVS	94 (18.4)	11 (68.8)	**<.0001**	83 (16.8)
RVD*	102 (20.0)	13 (81.2)	**<.0001**	89 (18.0)
McConnell sign	101 (19.8)	12 (75.0)	**.0003**	89 (18.0)
RiHT	9 (1.8)	3 (18.8)	**<.0001**	6 (1.2)
60/60 sign	66 (12.9)	5 (31.2)	.14	61 (12.3)
Distended IVC	66 (12.9)	3 (18.7)	.80	63 (12.7)

IVS, Interventricular septum; *RiHT*, right heart thrombus; *TAPSE*, tricuspid annular plane systolic excursion.

Data are expressed as mean ± SD or as number (percentage). Statistically significant *P* values are in boldface type.

Echocardiographic Pattern of Acute Pulmonary Embolism: Analysis of 511 Consecutive Patients
Katarzyna Kurnicka, MD, PhD, Barbara Lichodziejewska, MD, PhD, Sylwia Goliszek, MD, Olga Dzikowska-Diduch, MD, Olga Zdończyk, MD, Marta Kozłowska, MD, Maciej Kostrubiec, MD, PhD, Michał Ciurzyński, MD, PhD, Piotr Palczewski, MD, PhD, Katarzyna Grudzka, MD, Marcin Krupa, MD, Marcin Koć, MD, Piotr Pruszczyk, MD, PhD
Journal of the American Society of Echocardiography
Volume 29, Issue 9, Pages 907-913 (September 2016)

TES and potentially incidental echocardiographic findings according to the severity of PE and the presence of RVD

Parameter	All PE (n = 511)	High-risk PE (n = 16)	P	Non-high-risk PE RVD (n = 89)	P	Non-high-risk PE No RVD (n = 406)
McConnell sign	101 (19.8)	12 (75.0)	.79	70 (78.7)	**<.001**	19 (4.7)
RiHT	9 (1.8)	3 (18.8)	**.048**	2 (2.3)	.66	4 (1.0)
60/60 sign	66 (12.9)	5 (31.2)	.64	37 (41.6)	**<.001**	24 (5.9)
At least one TES	135 (26.4)	16 (100.0)	.60	77 (86.5)	**<.001**	42 (10.3)
Incidental findings*	46 (9.0)	6 (37.5)	**>.001**	3 (3.4)	.09	37 (9.1)

RiHT, Right heart thrombus.

Data are expressed as percentages. Statistically significant *P* values are in boldface type.

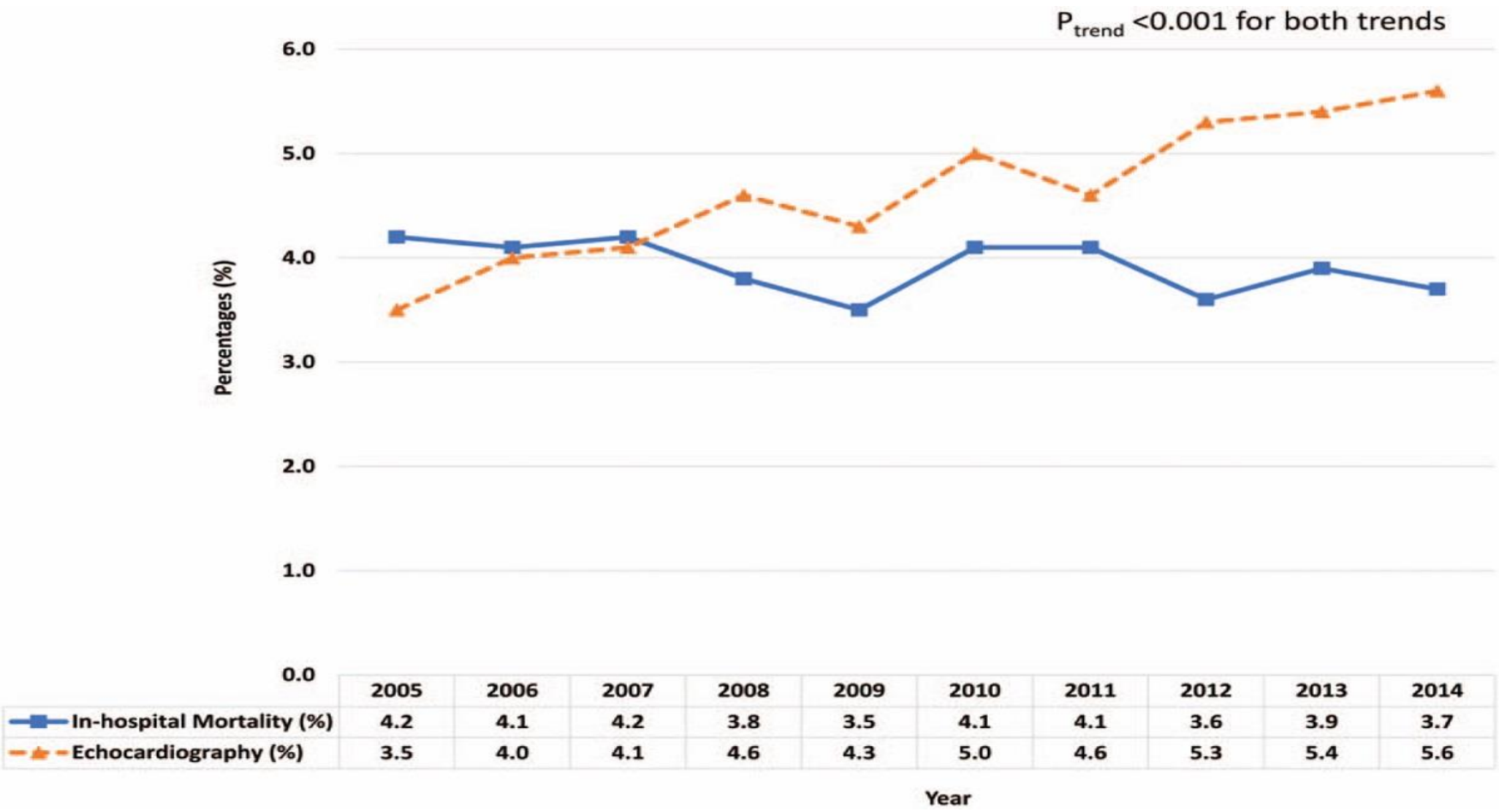
* Incidental echocardiographic findings were defined as the presence of LVEF ≤ 35%, significant AS or AR, or significant MR.

Echocardiographic Pattern of Acute Pulmonary Embolism: Analysis of 511 Consecutive Patients
Katarzyna Kurnicka, MD, PhD, Barbara Lichodziejewska, MD, PhD, Sylwia Goliszek, MD, Olga Dzikowska-Diduch, MD, Olga Zdończyk, MD, Marta Kozłowska, MD, Maciej Kostrubiec, MD, PhD, Michał Ciurzyński, MD, PhD, Piotr Palczewski, MD, PhD, Katarzyna Grudzka, MD, Marcin Krupa, MD, Marcin Koć, MD, Piotr Pruszczyk, MD, PhD
Journal of the American Society of Echocardiography
Volume 29, Issue 9, Pages 907-913 (September 2016)

Echocardiographic Pattern of Acute Pulmonary Embolism: Analysis of 511 Consecutive Patients
Katarzyna Kurnicka, MD, PhD, Barbara Lichodziejewska, MD, PhD, Sylwia Goliszek, MD, Olga Dzikowska-Diduch, MD, Olga Zdończyk, MD, Marta Kozłowska, MD, Maciej Kostrubiec, MD, PhD, Michał Ciurzyński, MD, PhD, Piotr Palczewski, MD, PhD, Katarzyna Grudzka, MD, Marcin Krupa, MD, Marcin Koć, MD, Piotr Pruszczyk, MD, PhD
Journal of the American Society of Echocardiography
Volume 29, Issue 9, Pages 907-913 (September 2016)

- 71% ασθενών με Π.Ε χωρίς ευρήματα από τον υπέρηχο
- 10% τυχαία ευρήματα στον υπέρηχο
- Υψηλού κινδύνου ασθενείς-διατεταμένη υποκινητική RV
- RVD κριτήριο – McConnell + 1 σημείο επιπλέον

Υπέρηχος και διαστρωμάτωση κινδύνου



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
In-hospital Mortality (%)	4.2	4.1	4.2	3.8	3.5	4.1	4.1	3.6	3.9	3.7
Echocardiography (%)	3.5	4.0	4.1	4.6	4.3	5.0	4.6	5.3	5.4	5.6

Trends in the use of echocardiography in pulmonary embolism

Patel, Brijesh, DO[a,*]; Shah, Mahek, MD[a]; Garg, Lohit, MD[a]; Agarwal, Manyoo, MD[b]; Martinez, Matthew, MD, Faculty[a]; Dusaj, Raman, MD[a]
Section Editor(s): Insalaco., Giuseppe

Medicine: August 2018 - Volume 97 - Issue 35 - p e12104

Υπέρηχος και Θνητότητα

Outcome	PE without ECHO	PE with ECHO	P
Before propensity			
In-hospital mortality, %	3.9	4.0	.75
Odd ratio (95% confidence interval)	1.07 (0.99–1.15)		
Length of stay in days, median (IQR)	5 (3–7)*	6 (4–9)†	<.001
Total charges in US dollars, median (IQR)	24,366 (14,478–43,027)*	34,468 (19,954–65,023)†	<.001
After propensity			
In-hospital mortality, %	5.2	3.9	<.001
Odd ratio (95% confidence interval)	0.75 (0.68–0.83)		
Length of stay in days, median (IQR)	5 (3–8)‡	6 (4–9)§	<.001
Total charges in US dollars, median (IQR)	27,803 (16,195–50,415)‡	34,379 (19,922–64,794)§	<.001

IQR = interquartile range, PE = pulmonary embolism.

* 269,577 cases.

† 13,008 cases.

‡ 25,697.

§ 12,970.

Trends in the use of echocardiography in pulmonary embolism

Patel, Brijesh, DO[a,*]; Shah, Mahek, MD[a]; Garg, Lohit, MD[a]; Agarwal, Manyoo, MD[b]; Martinez, Matthew, MD, Faculty[a]; Dusaj, Raman, MD[a]
Section Editor(s): Insalaco., Giuseppe

Medicine: August 2018 - Volume 97 - Issue 35 - p e12104

Υπέρηχος και διαστρωμάτωση κινδύνου

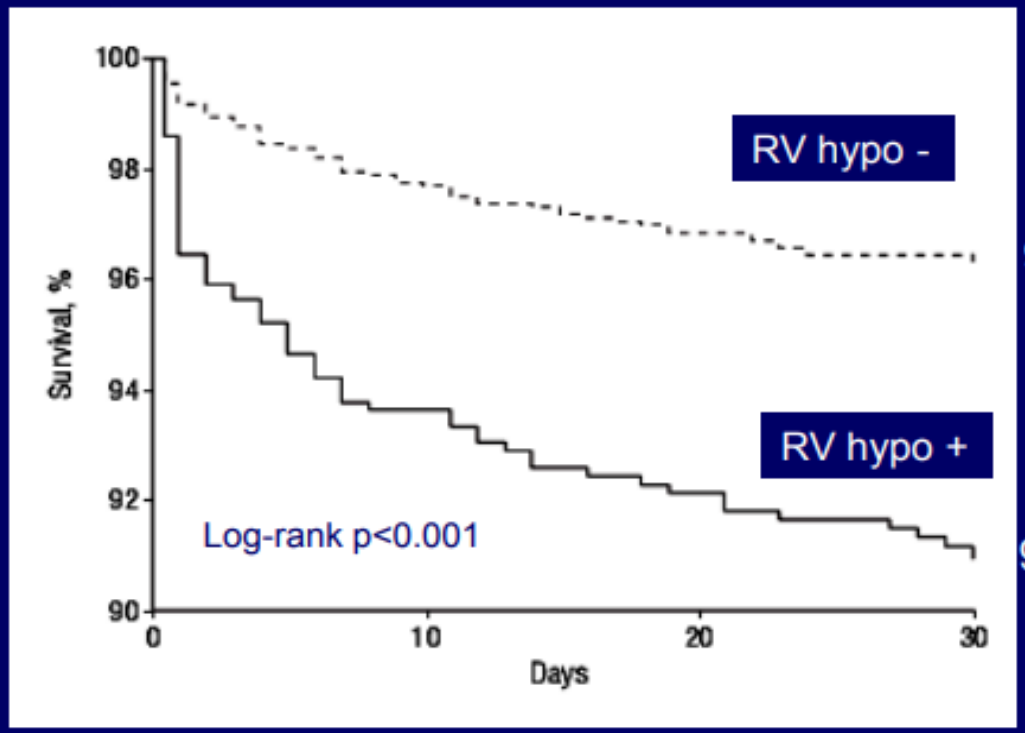
Table 3. Mortality in Patients With Pulmonary Embolism With and Without Right Ventricular Dysfunction

			Total Mortality, No. (%)				Mortality Related to PE, No. (%)			
	No. of Patients		Short-term		Long-term		Short-term		Long-term	
Source	RVD Present	RVD Absent	RVD Present	RVD Absent	RVD Present	RVD Absent	RVD Present	RVD Absent	RVD Present	RVD Absent
Goldhaber et al,[8] 1993	46	55	2 (4)	0	NDA	NDA	2 (4)	0	NDA	NDA
Ribeiro et al,[9] 1997	70	56	10 (14)	0	15 (21)	4 (7)	9 (13)	0	9 (13)	0
Kasper et al,[10] 1997	87*	230*	16 (18)	13 (6)	16 (18)	14 (6)	11 (13)	2 (1)	11 (13)	3 (1)
Goldhaber et al,[7] 1999	NDA	NDA	16†	8†	21†	15†	NDA	NDA	NDA	NDA
Grifoni et al,[11] 2000	110 (65‡)	99 (97‡)	14 (13)	3 (3)	NDA	NDA	13 (12) (3 [5]‡)	0	NDA	NDA
Grifoni et al,[18] 2001	48	69	NDA	NDA	4 (8)	8 (11)	NDA	NDA	3 (3)	0
Jerjes-Sanchez et al,[19] 2001	28	12	5 (18)	0	NDA	NDA	4 (14)	0	NDA	NDA

Abbreviations: NDA, no data available; PE, pulmonary embolism; RVD, right ventricular dysfunction.
*Pulmonary embolism was not objectively confirmed in all patients.
†Percentage estimated from the Kaplan-Meier curve.
‡Normotensive patients.

Impact of RV Dysfunction on Survival* in Pts with Acute PE and Preserved Systolic Arterial Pressure

- *1035 ICOPER pts with PE*
- *SBP ≥ 90 mmHg at presentation*
- *Baseline echo for RV hypokinesis*



96.4%

91.0%

RV hypokinesis in pts with PE and SBP ≥90mmHg:

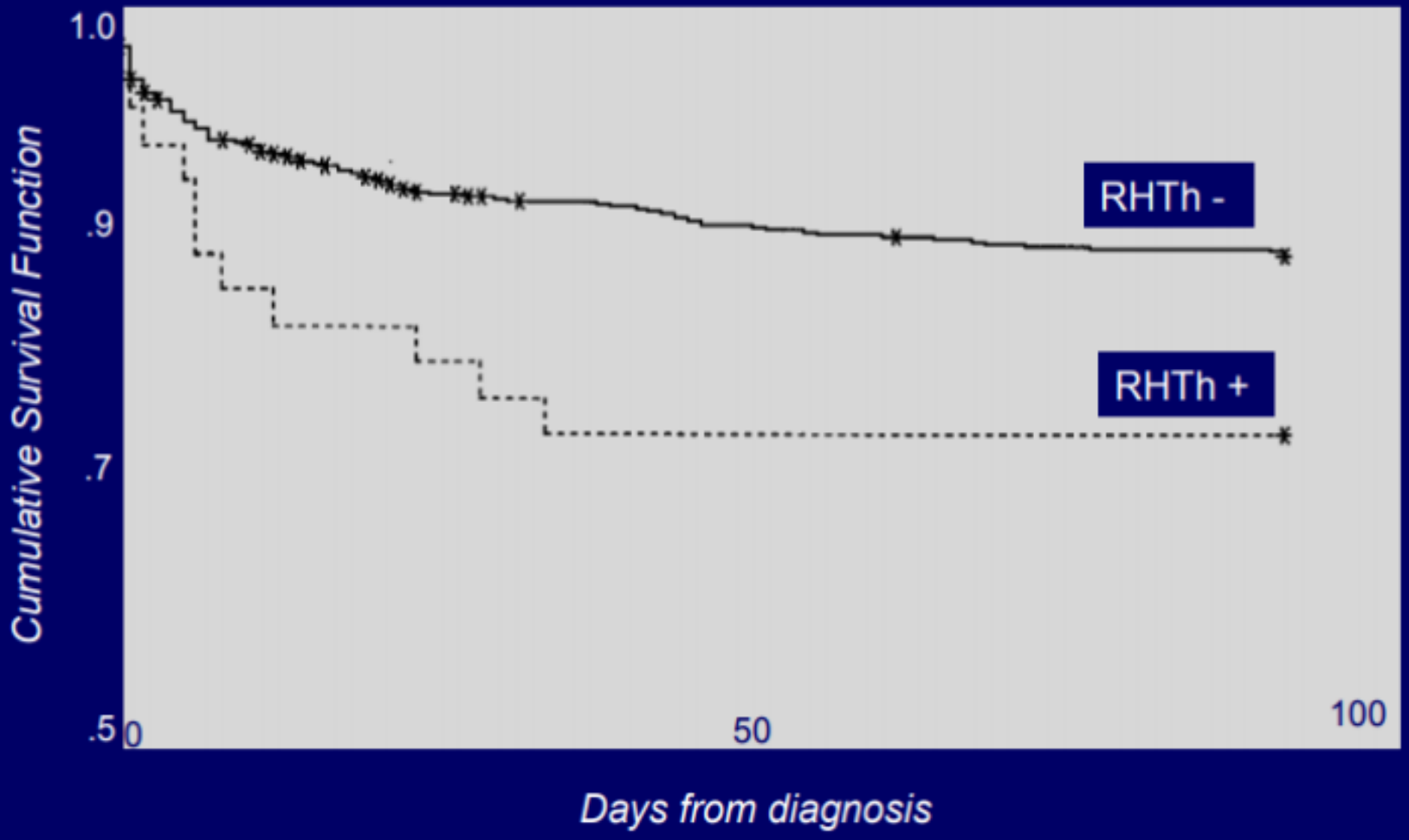
Independent predictor of 30-day mortality

HR 1.94 (1.23-3.06)

**, Survival adjusted for: cancer, CHF, COPD, age, and TA*

Kucher N, et al (ICOPER). Arch Intern Med 2005

3-Month Survival According to the Presence or Absence Of Right Heart Thrombi on Baseline Echo

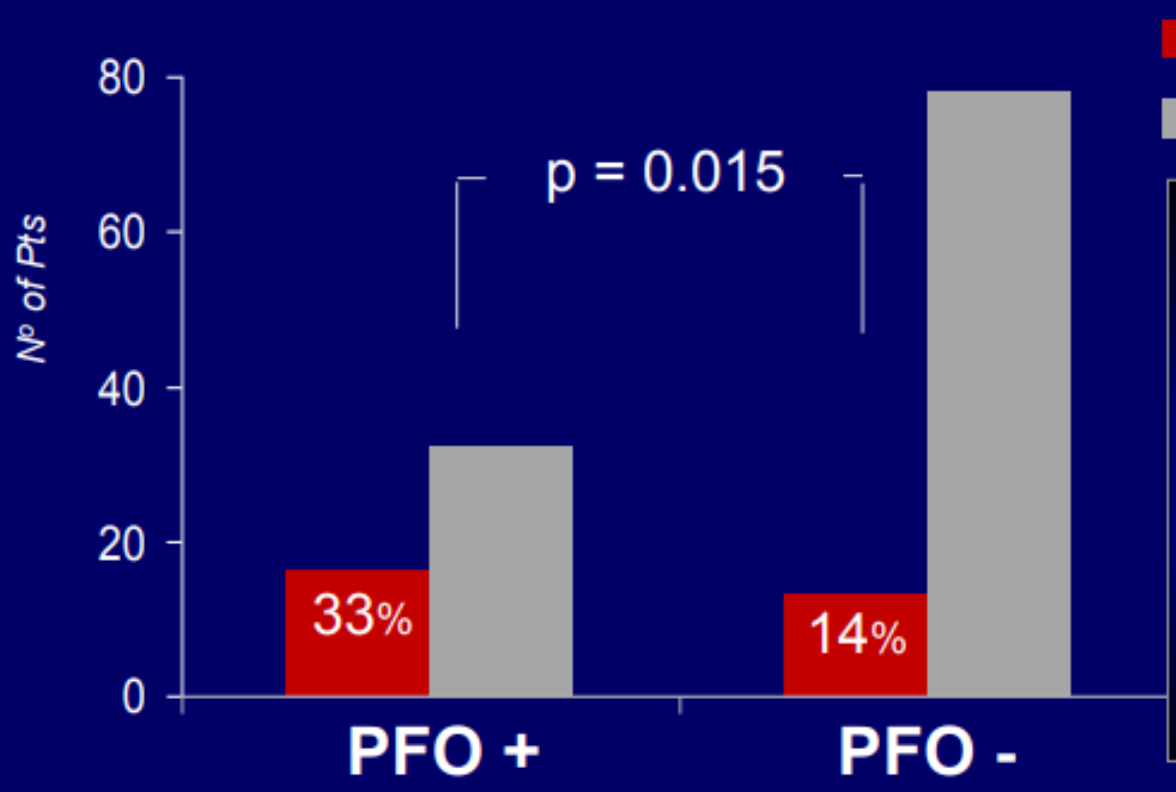


Torbicki A, et al (ICOPER). JACC 2003

PFO is Important Predictor of Adverse Outcome in Pts with Major PE

- *139 consecutive with major PE*
- *Contrast Echo for PFO detection at presentation*
- *F/U: in-hospital death and complications*

PFO in 48/139 pts (35%)



PFO+ *vs* PFO-

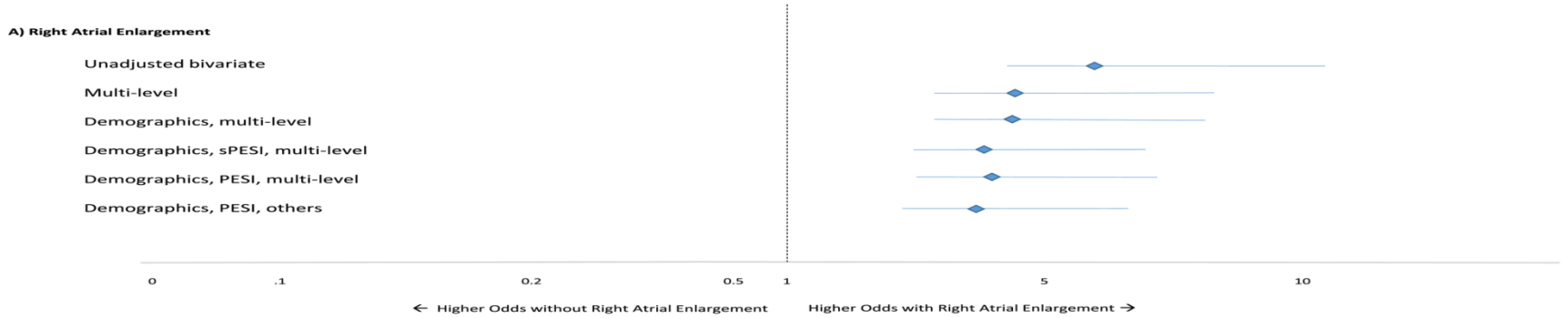
Ischemic stroke

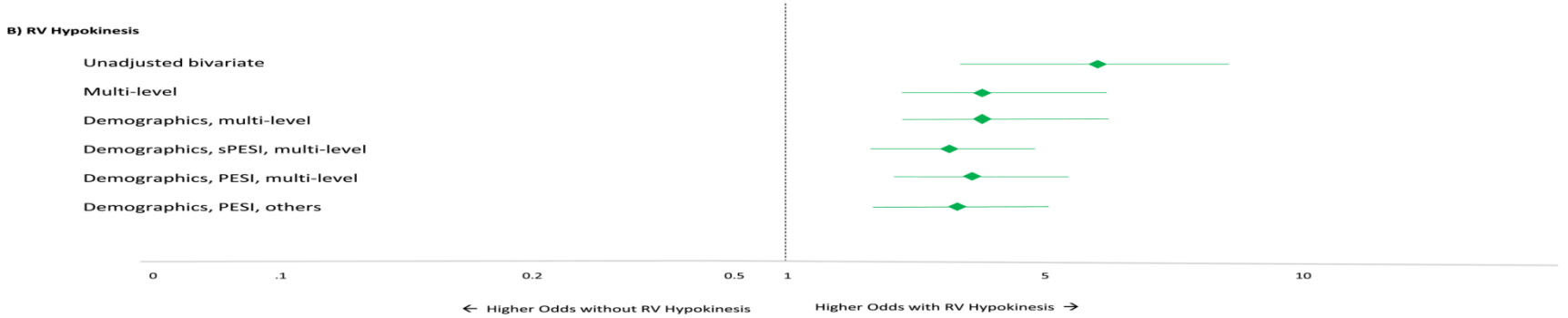
13% *vs* 2.2 %, p=.02

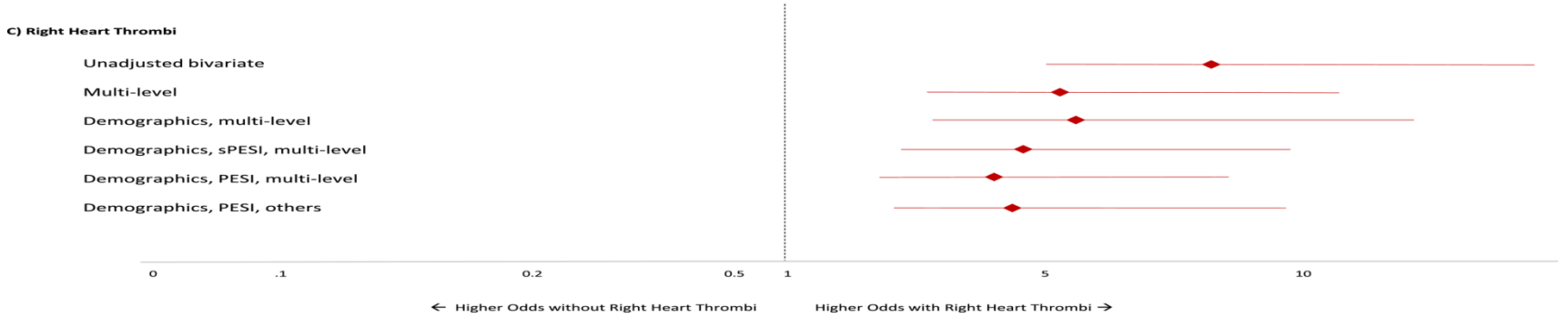
Peripheral artery embolism

15% *vs* 0%, p<.001

Konstantinides S, et al. Circ 1998


A) Right Atrial Enlargement
Unadjusted bivariate
Multi-level
Demographics, multi-level
Demographics, sPESI, multi-level
Demographics, PESI, multi-level
Demographics, PESI, others
0
.1
0.2
0.5
1
5
10
← Higher Odds without Right Atrial Enlargement
Higher Odds with Right Atrial Enlargement →


B) RV Hypokinesis
Unadjusted bivariate
Multi-level
Demographics, multi-level
Demographics, sPESI, multi-level
Demographics, PESI, multi-level
Demographics, PESI, others
0
.1
0.2
0.5
1
5
10
← Higher Odds without RV Hypokinesis
Higher Odds with RV Hypokinesis →


C) Right Heart Thrombi
Unadjusted bivariate
Multi-level
Demographics, multi-level
Demographics, sPESI, multi-level
Demographics, PESI, multi-level
Demographics, PESI, others
0
.1
0.2
0.5
1
5
10
← Higher Odds without Right Heart Thrombi
Higher Odds with Right Heart Thrombi →

Κριτήρια διεξαγωγής υπερήχου

Variables	Odd ratio (95% confidence interval)	P
Thrombolytics	1.27 (1.15–1.40)	<.001
Acute deep vein thrombosis	1.05 (1.02–1.09)	.004
Hypotension	1.34 (1.24–1.45)	<.001
Atrial fibrillation or flutter	1.50 (1.43–1.58)	<.001
Syncope	1.44 (1.30–1.59)	<.001
Acute respiratory failure	1.25 (1.19–1.32)	<.001
Ischemic stroke	2.89 (2.54–3.28)	<.001
Hospital status		
Rural	Reference	
Urban nonteaching	1.26 (1.17–1.35)	<.001
Urban teaching	2.29 (2.13–2.46)	<.001
Size of hospital		
Small	Reference	
Medium	1.36 (1.28–146)	<.001
Large	1.69 (1.59–1.80)	<.001

Trends in the use of echocardiography in pulmonary embolism. Patel, Brijesh, DO[a,*]; Shah, Mahek, MD[a]; Garg, Lohit, MD[a]; Agarwal, Manyoo, MD[b]; Martinez, Matthew, MD, Faculty[a]; Dusaj, Raman, Md[a].Section Editor(s): Insalaco., Giuseppe.Medicine: August 2018 - Volume 97 - Issue 35 - p e12104

Κριτήρια διεξαγωγής υπερήχου

Take Home Messages

- TTE ΟΧΙ για διάγνωση ΠΕ σε χαμηλού κινδύνου ασθενείς-screening

- TTE βοηθητικό για διάγνωση HIGH RISK ασθενών –SAP< 90mmHg αν βρεθούν σημεία RVD

- TTE για διαστρωμάτωση κινδύνου-άγνωστο σε ποιους ασθενείς μετρίου κινδύνου πρέπει να διεξάγεται