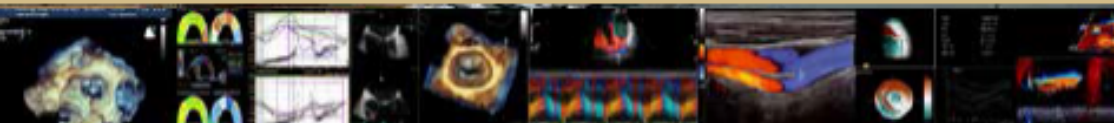




Società Italiana di Ecografia Cardiovascolare

[WWW.SIEC.IT](http://WWW.SIEC.IT)



**ECOCARDIOGRAFIA 2015**  
**XVII Congresso Nazionale SIEC**

Hotel Royal Continental

Napoli, 16-18 Aprile 2015

## IMAGING E CLINICA NELL'EMBOLIA POLMONARE

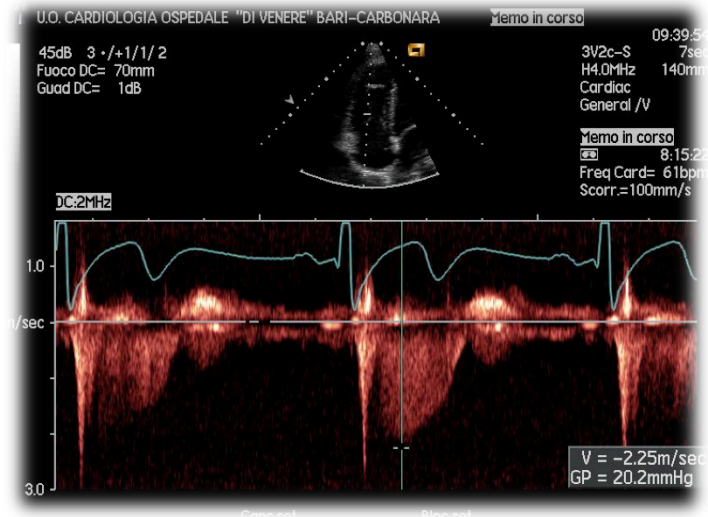
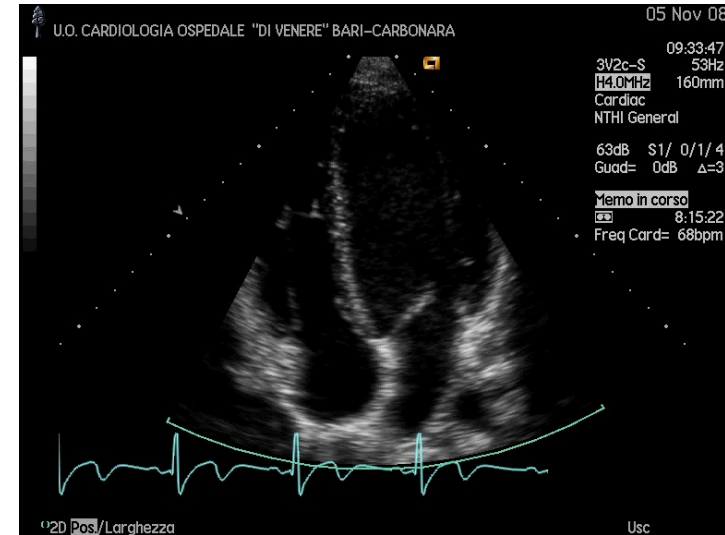
Ventricolo destro:  
dalla pressione alla funzione

**Dott. Nicola D'Amato**  
Bari

# IL VENTRICOLO DESTRO

❖ Svolge la sua funzione di pompa muscolare in un sistema vascolare a basse resistenze. Generando un basso regime pressorio presenta una parete sottile.

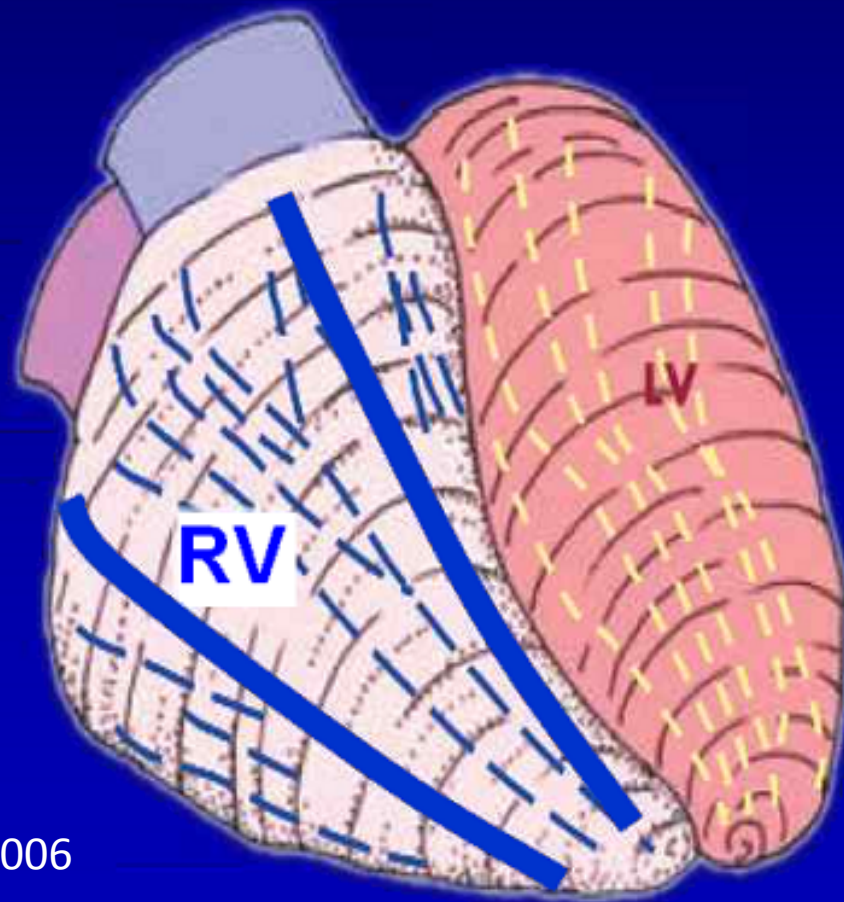
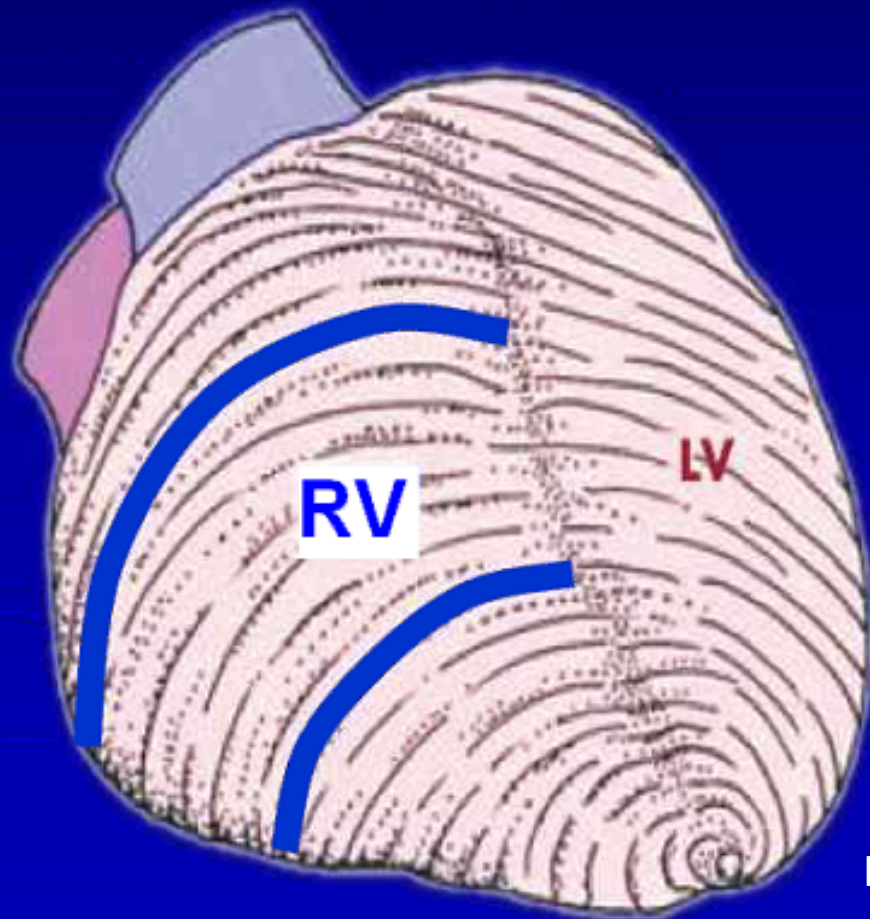
❖ Nella pratica clinica quotidiana raramente se ne valuta la funzione.



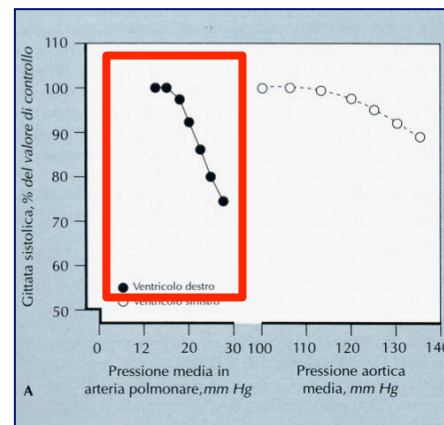
# Fibre Direction

epicardial

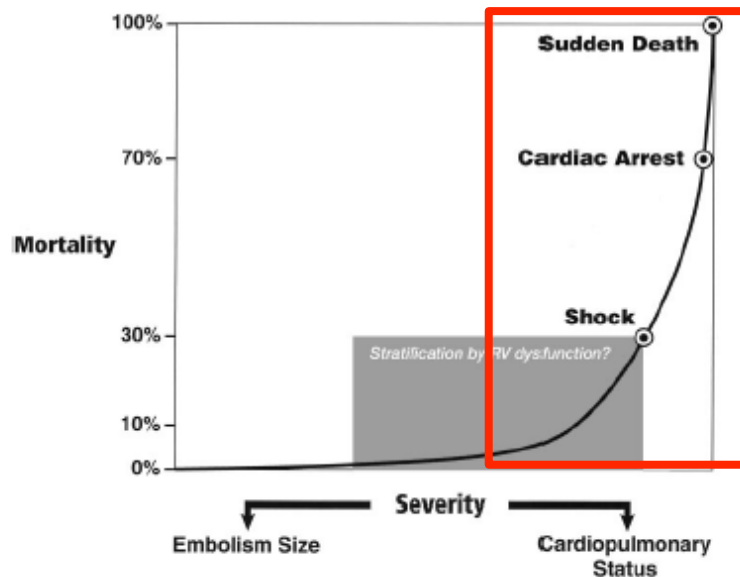
endocardial

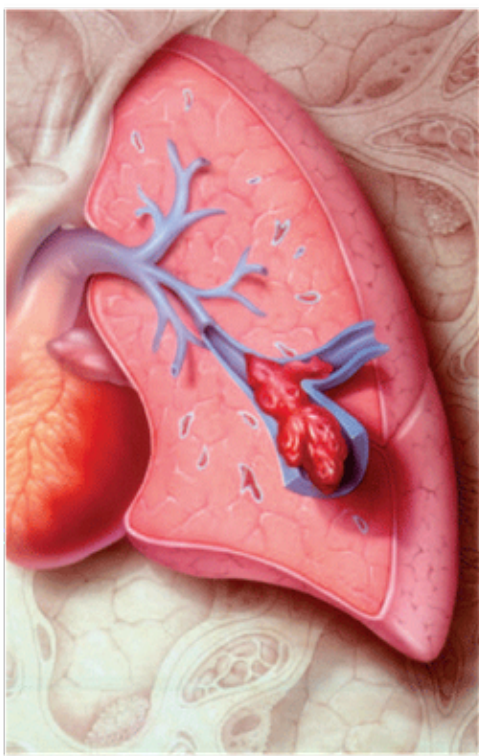


# Relazione tra gravità dell'embolia e mortalità



## Outcomes in Pulmonary Embolism



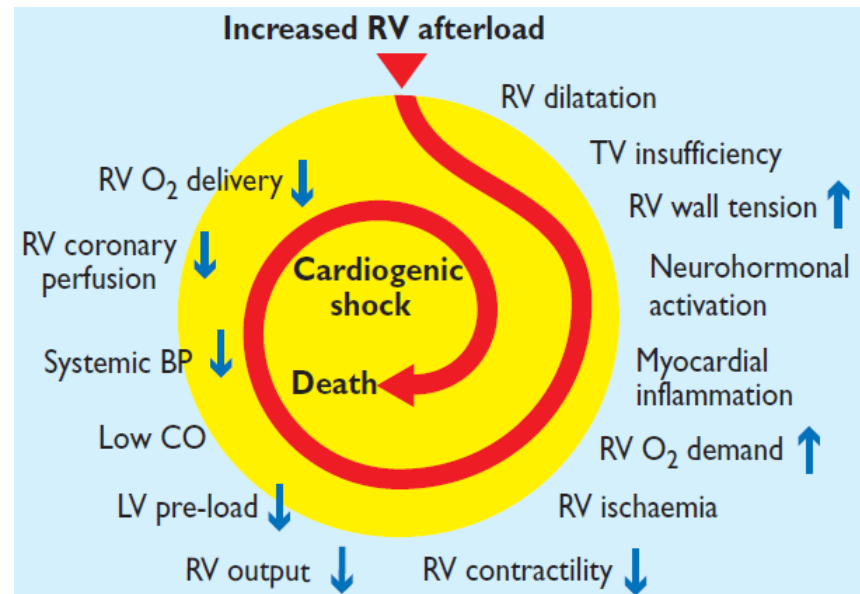
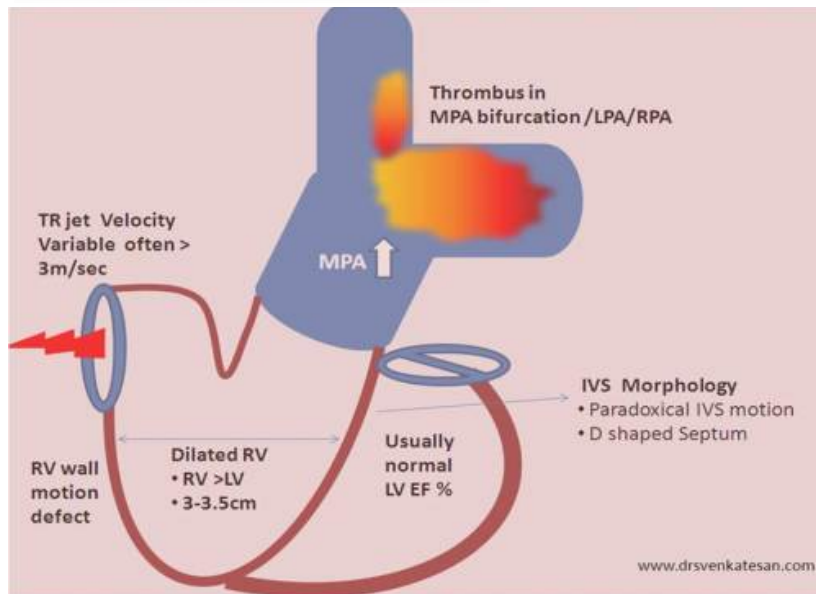


# EMBOLIA POLMONARE ACUTA

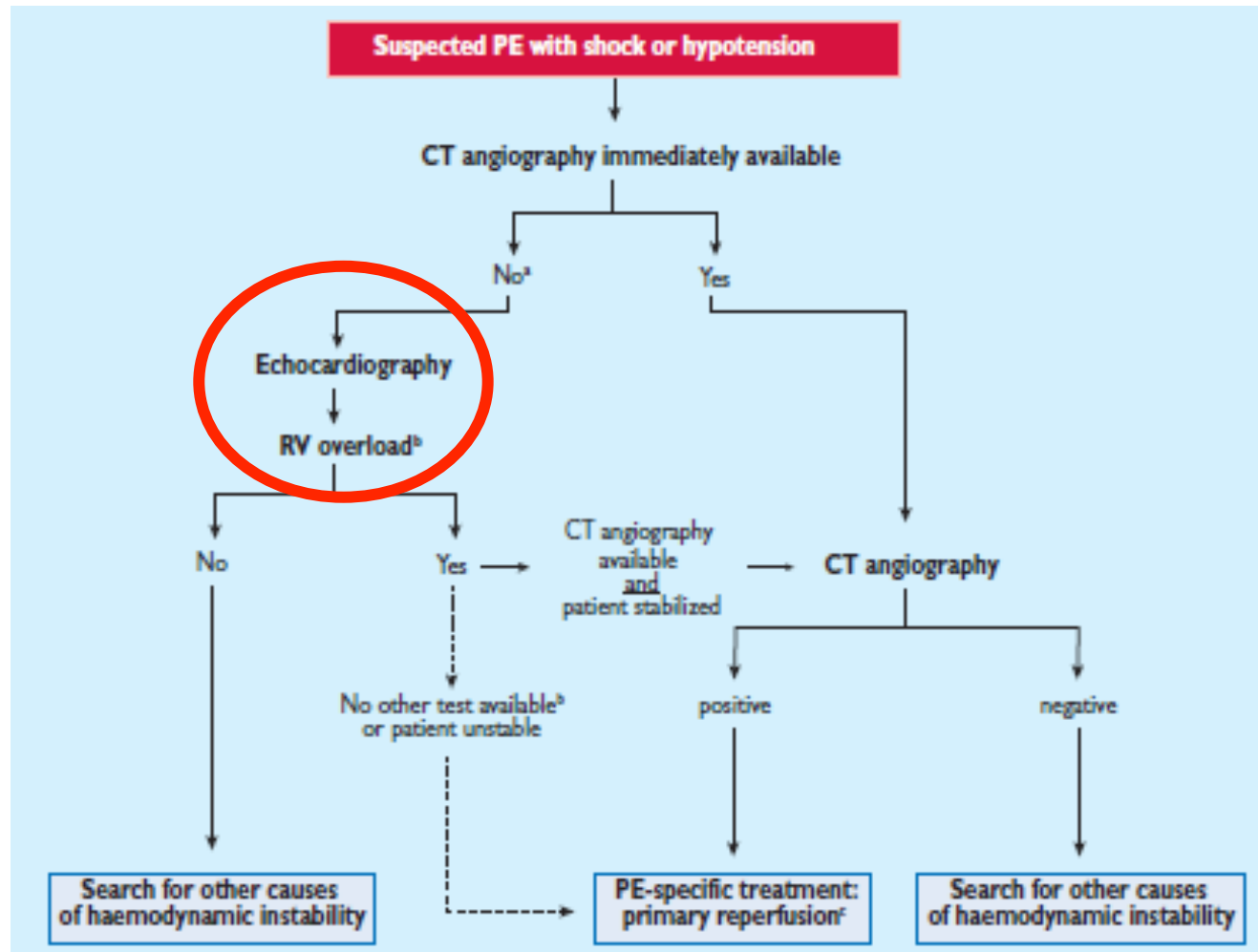
Emergenza cardiovascolare potenzialmente letale

La diagnosi ed il trattamento precoce sono fondamentali

Il 25% delle EP si associa a dilatazione e disfunzione VD



# 2014 ESC Guidelines on the diagnosis and management of acute pulmonary embolism





**Paziente instabile con inspiegato shock/edema polmonare**

**Eco rapido e limitato con apparecchi portatili e con un ridotto numero di finestre (sottocostale e apicale)**

**VP  $\geq$  moderato  
Compressione RV/RA  
IVC Dilatata**

**Tamponamento**

**RV severamente dilatato  
e ipoacinetico**

**Embolia  
Polmonare**

**LV severamente ipo/  
acinetico**

**Insufficienza  
cardiaca acuta**

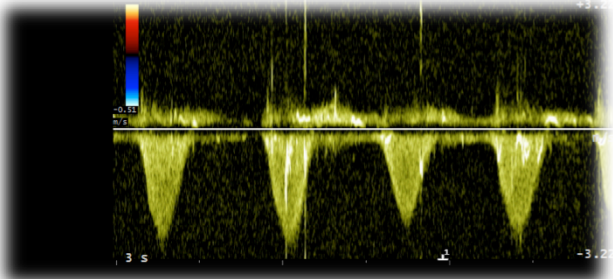
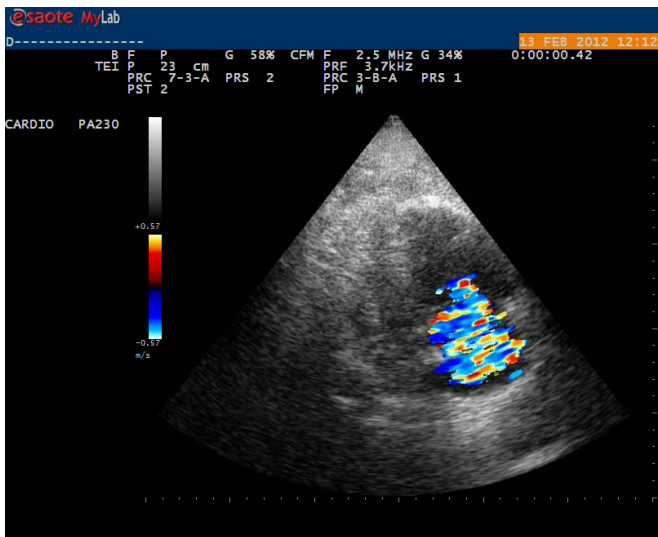
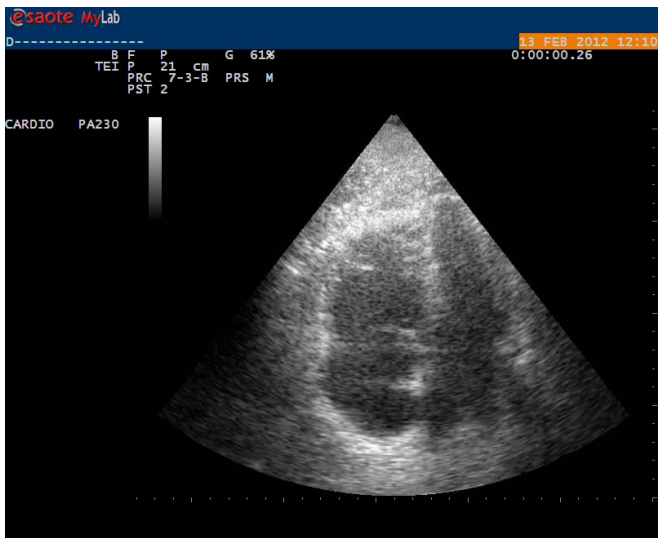
**IMA?  
Miocardite?  
Tossicosi?**

**Cuore piccolo  
iperdinamico  
IVC Collassata**

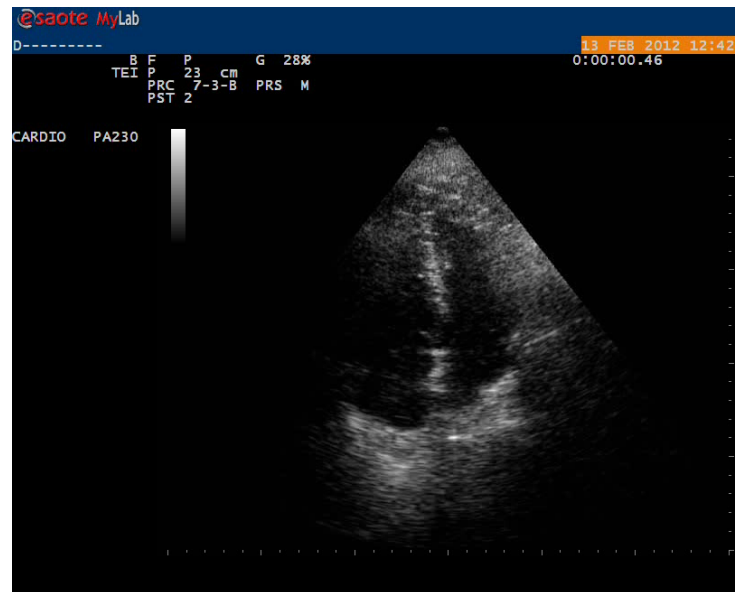
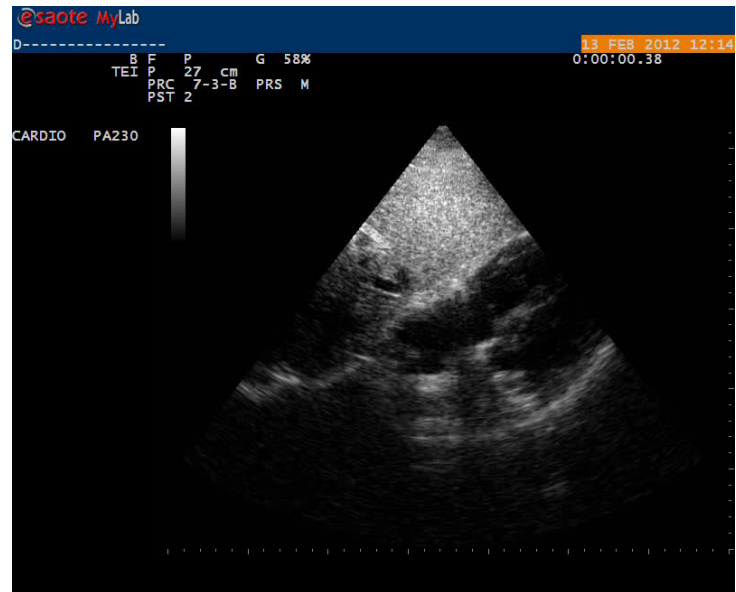
**Grave  
Ipovolemia**

**Emorragia  
interna  
maggiore**

**Sepsi  
Altro**

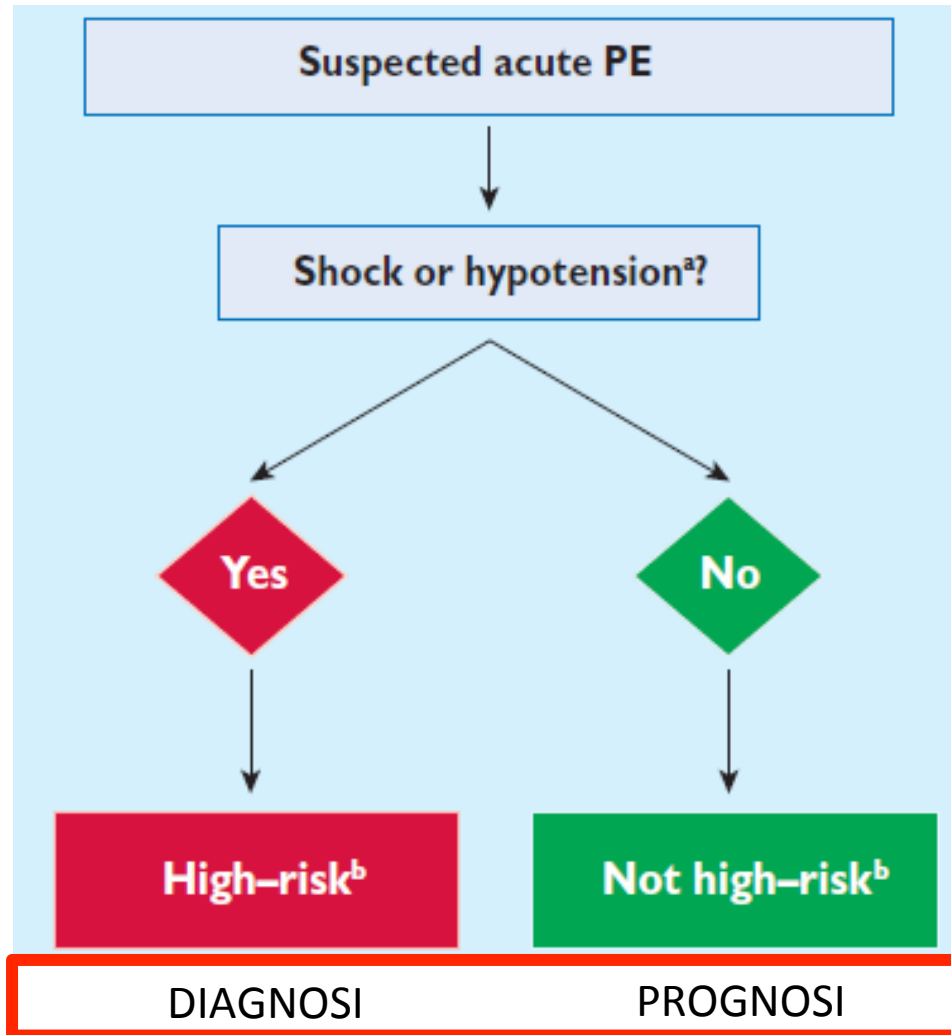


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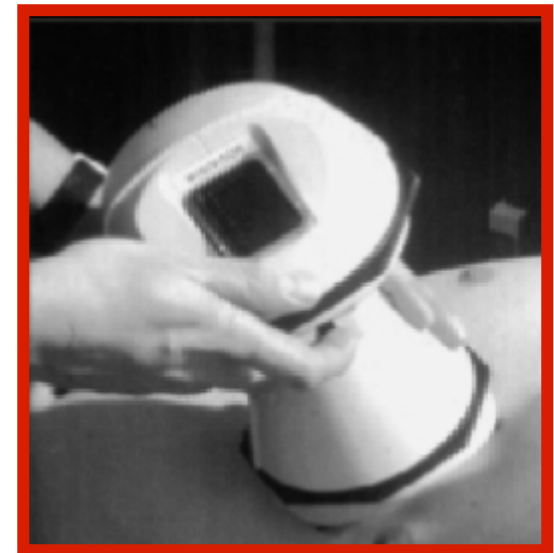
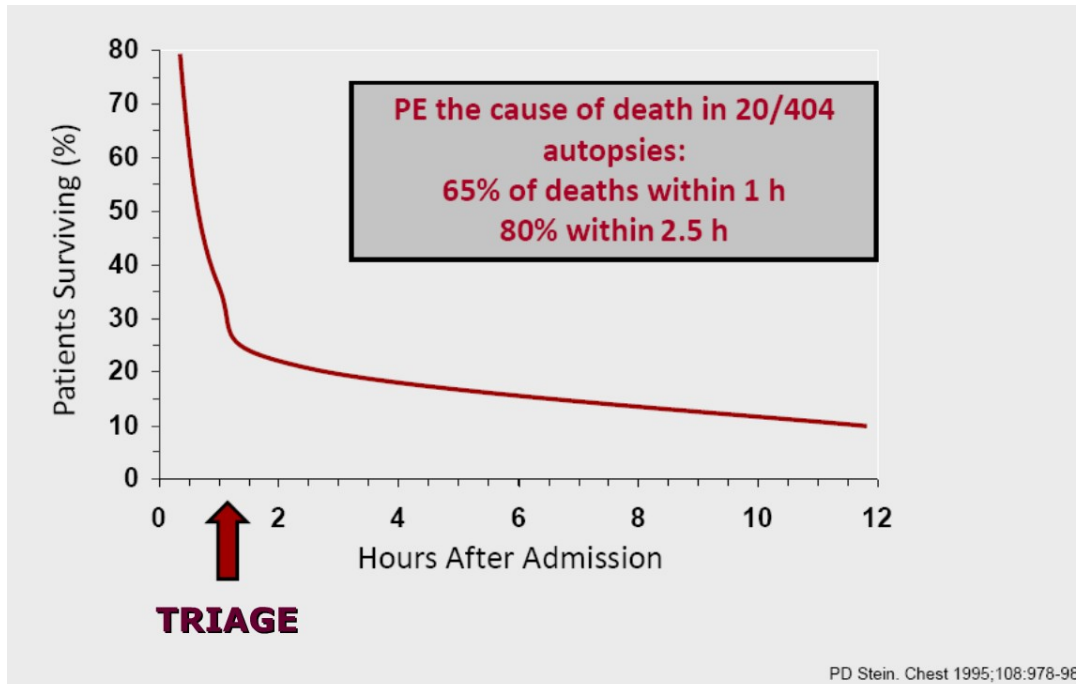
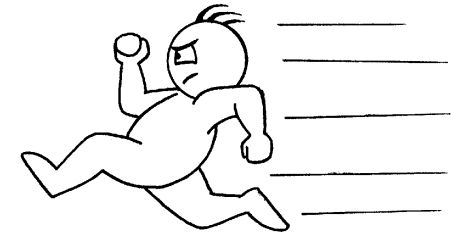
# VALORE AGGIUNTO DELL'ECOCARDIOGRAFIA



# GOLDEN HOUR

## Embolia Polmonare – paziente critico

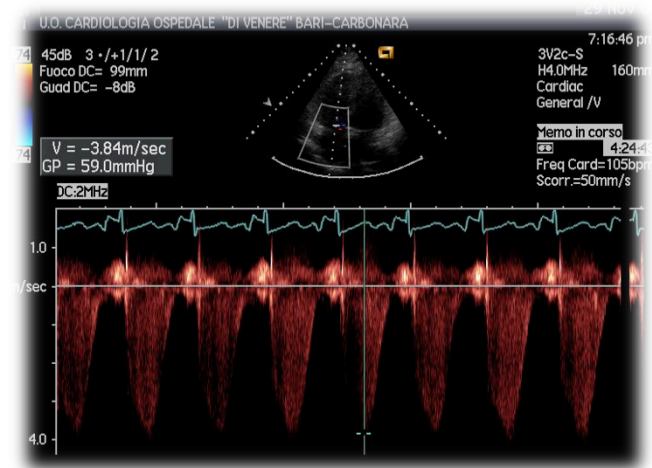
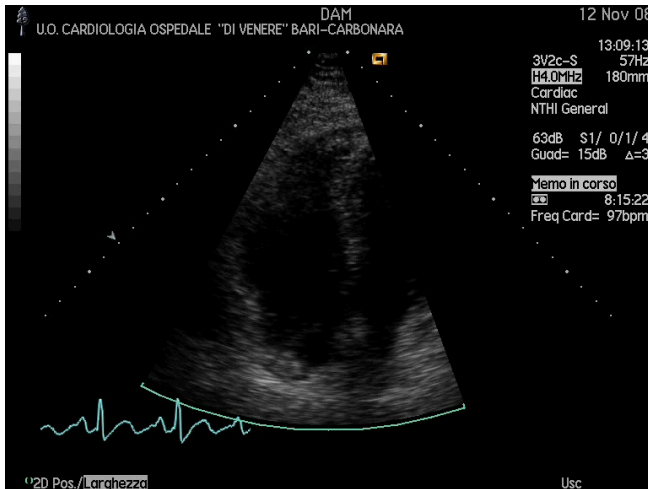
(sensibilità 95-100%)



# EMBOLIA POLMONARE

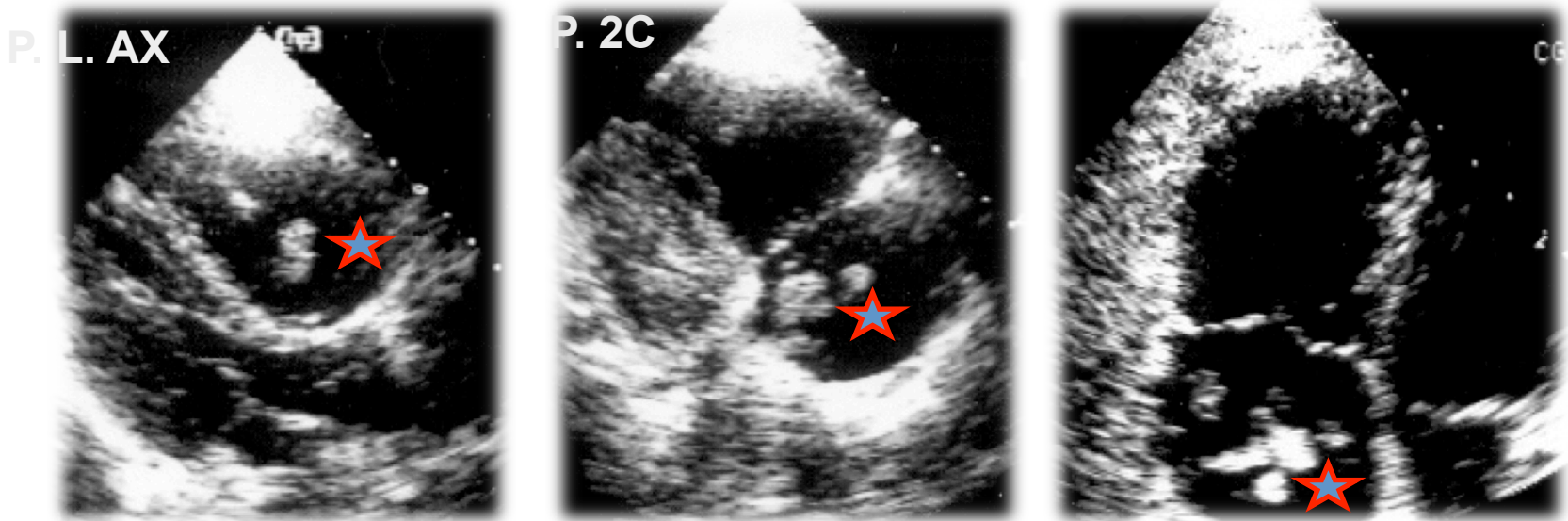
Resistenza all'eiezione del ventricolo destro

Incremento della pressione polmonare



- L'adattamento funzionale del VD alle condizioni di carico emodinamico è fondamentale per lo stato di salute cardio-circolatoria.
- La performance del VD è strettamente legata allo stato clinico del paziente.
- La capacità funzionale del VD è un fattore indipendente di mortalità.

# Segni diretti di MTV

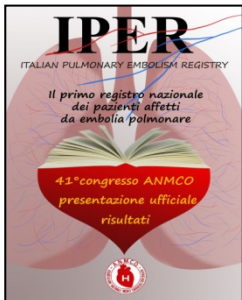
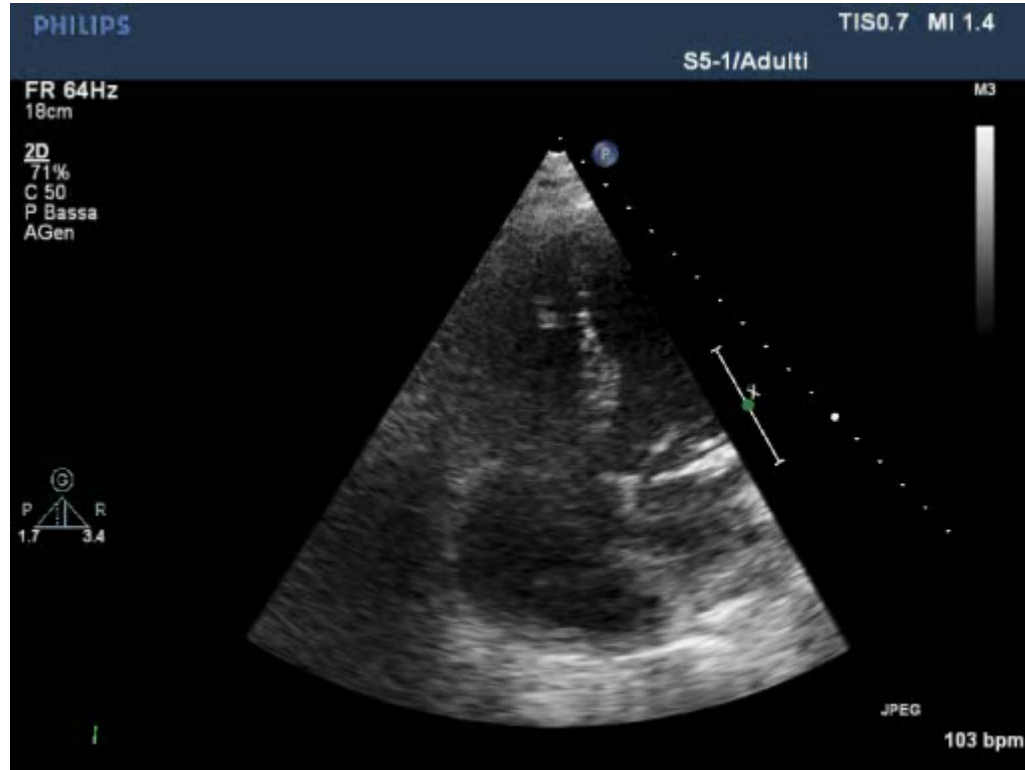


Tromboemboli in transito sono presenti nel 4% dei casi di EP (ICOPER)

La mortalità è particolarmente elevata (21% vs 11%  $p=0.06$  ).

# Segni diretti di MTV

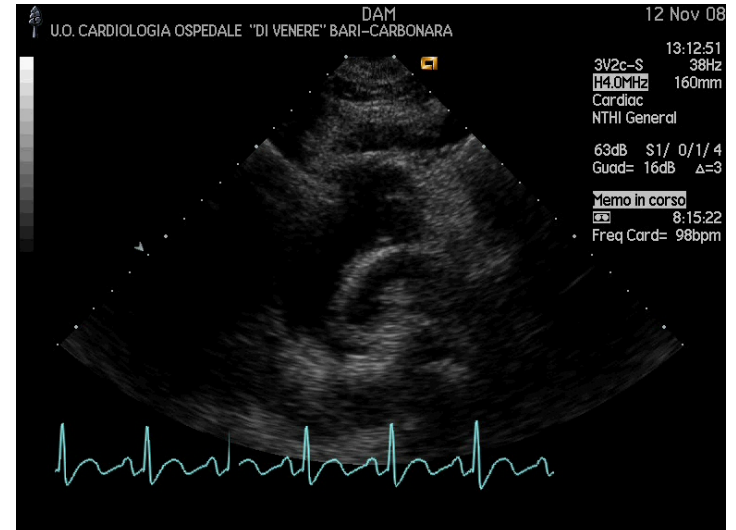
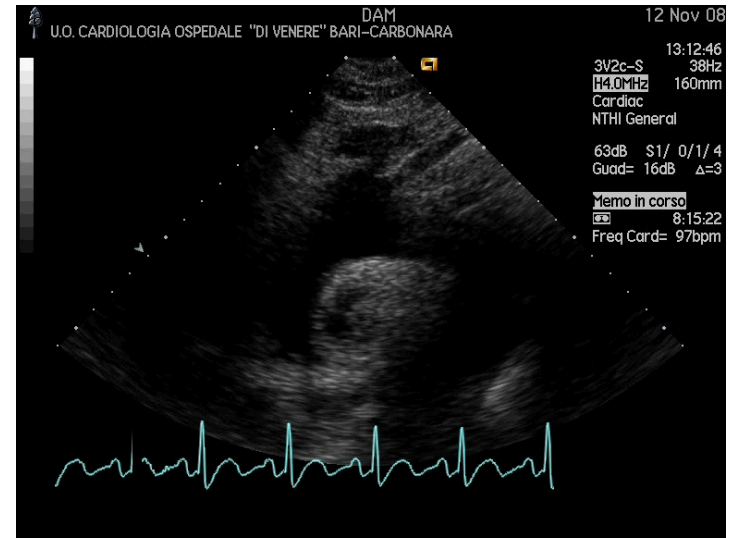
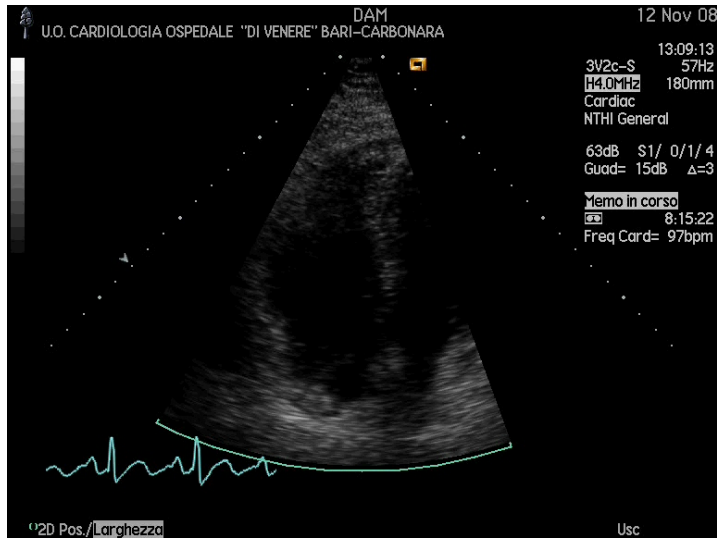
## Trombi di tipo A in atrio destro



**non alto rischio**  
**alto rischio**

→ **2.8 %**  
→ **14.4%**

# Embolia polmonare acuta MTV (Trombofilia familiare)



# Characteristics of Pts With and Without Right Heart Thrombi on Baseline Echo

- 2452 ICOPER pts with PE
- 1113 have baseline ECHO
- 42 RHT+ and 1071 RHT-

	Right Heart Thrombi + (42 pts)	Right Heart Thrombi - (1071 pts)	<i>P value</i>
CHF	26%	13%	0.024
Heart rate	107 <sub>±</sub> 19	101 <sub>±</sub> 22	0.030
Systolic BP	116 <sub>±</sub> 29	126 <sub>±</sub> 25	0.008
Systolic BP <90	14%	5%	0.012
Respiratory rate	28 <sub>±</sub> 8	25 <sub>±</sub> 10	0.037
RBBB	27%	13%	0.023
RV hypo (Echo)	64%	40%	0.002
<b>Mortality at 14 d</b>	21%	11%	0.032
<b>Mortality at 3 mo</b>	29%	16%	0.036

# Fisiopatologia nell'EP Acuta

## ➤ Brusco incremento del post-carico ventricolare destro

## ➤ Incremento della pressione polmonare media da riduzione meccanica e funzionale del letto vascolare polmonare.

(Un'ostruzione superiore al 40-50% del letto vascolare polmonare, per meccanismo occlusivo e vasospastico, induce un aumento della PAP media fino a 40 mmHg.)

## ➤ Dilatazione ed ipocinesia del ventricolo destro

(Il ventricolo destro ha una limitata tolleranza al sovraccarico pressorio acuto, ne consegue una disfunzione caratterizzata da dilatazione e deficit contrattile.)

## ➤ Dislocazione a sinistra del setto interventricolare e fenomeno dell'interdipendenza ventricolare

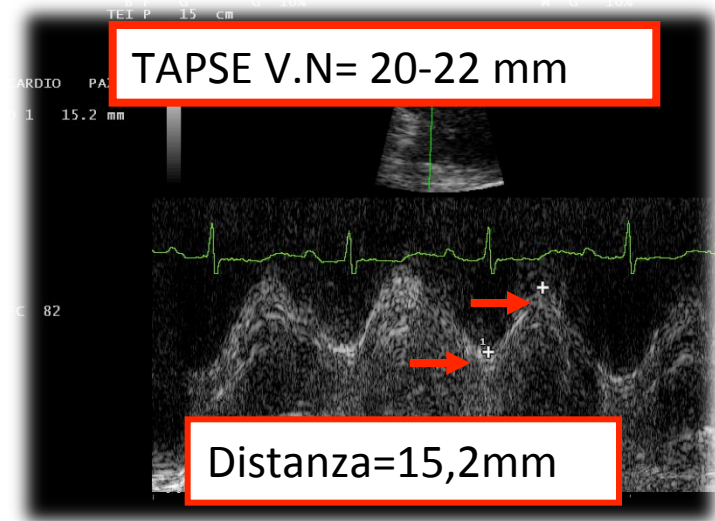
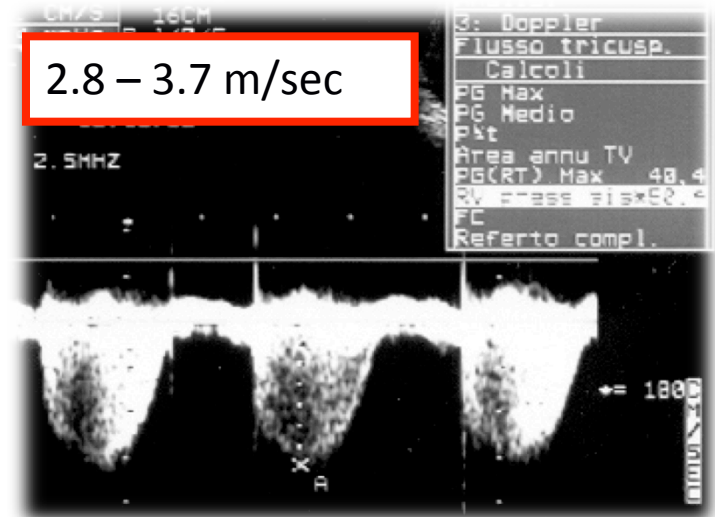
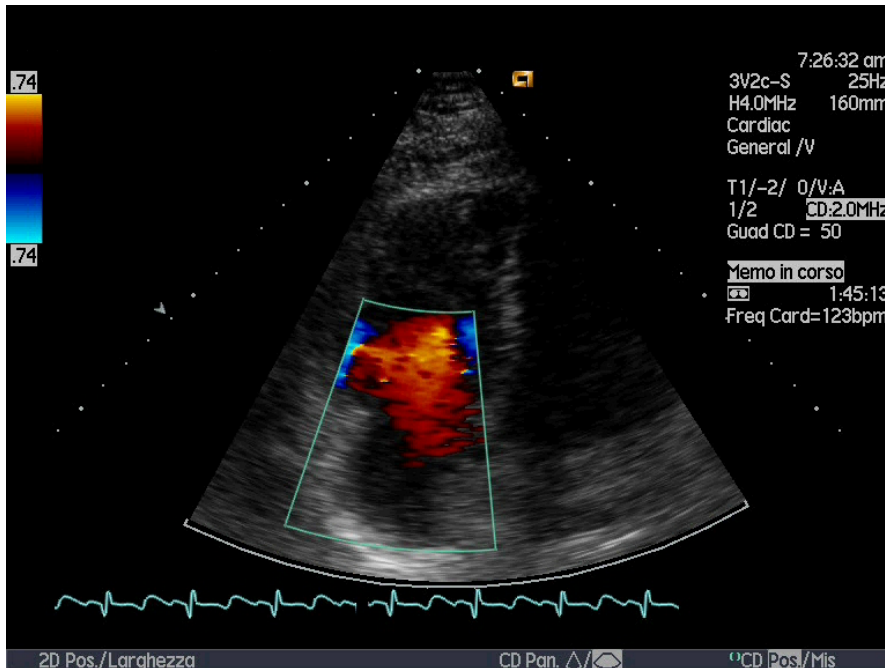
(riduzione del riempimento del ventricolo sinistro, ridotta gittata fino all'ipotensione ed allo shock). A livello miocardico la condizione di ischemia complica e giustifica l'incremento dei marcatori di necrosi (es. Troponina I) presente in alcuni casi. Lo stiramento delle fibre induce immissione in circolo di peptidi natriuretici (BNP).



# Cuore ed Embolia Polmonare Acuta

- ✓ Disfunzione Ventricolare Destra  
Ventricolo Destro non ipertrofico  
Aumento della PAPs

I.T.



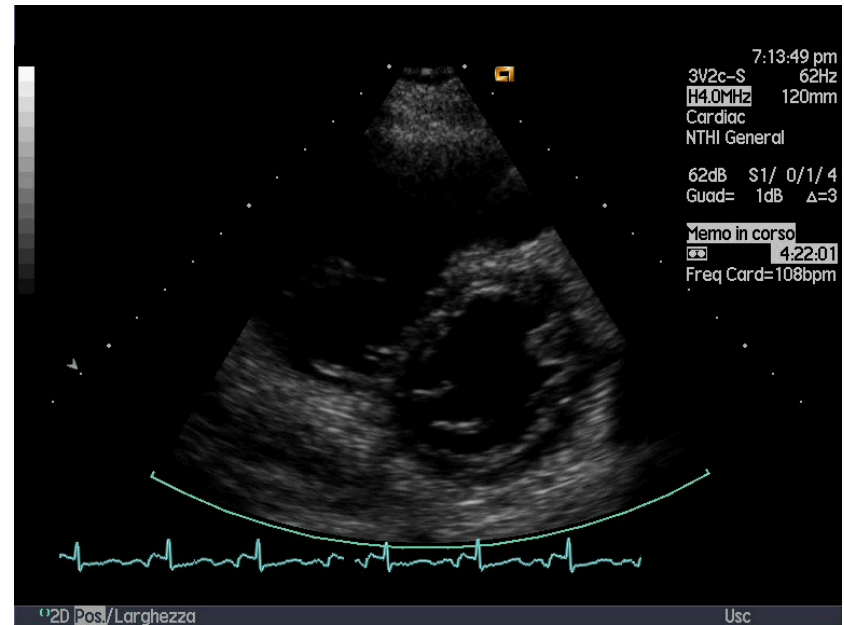
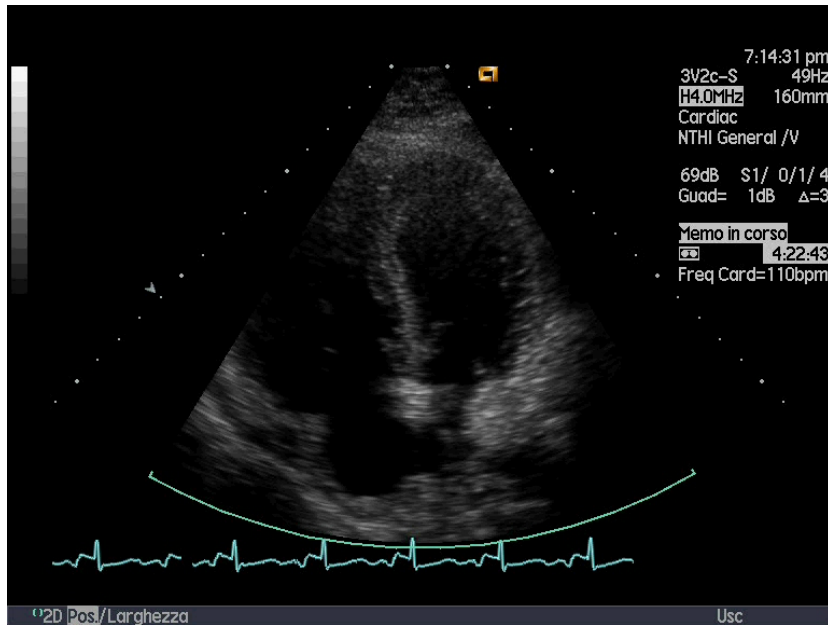


# Right ventricular apical contractility in acute pulmonary embolism: the McConnell sign revisited

## CONCLUSIONS:

Therefore, regional RVa function is not truly spared in aPE and the **probable visual illusion of preserved contractility** might ~~simply reflect tethering of the RVa to a~~ hyperdynamic left ventricle in the presence of an acutely dilated RV.

# Segni indiretti anatomo-funzionali (dissincronia di contrazione)

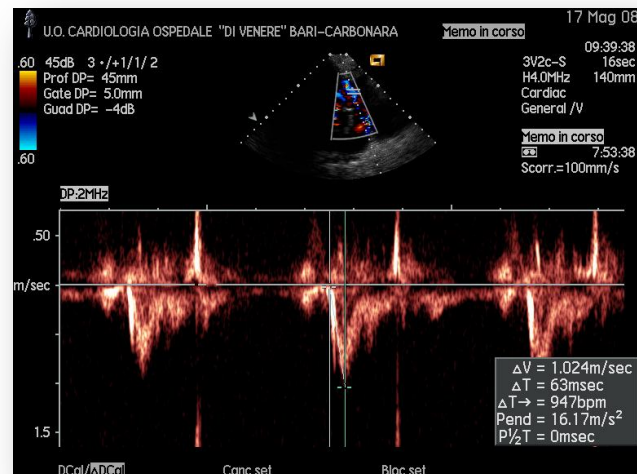


# Stima della pressione arteriosa polmonare

Pressione polmonare sistolica (aumento delle resistenze)

Con l'aumentare della pressione polmonare sistolica (aumento delle resistenze vascolari) cambia la morfologia di flusso sistolico polmonare. Si accorcia il tempo di accelerazione polmonare (PA ACT) tempo che intercorre tra l'inizio e l'apice del jet polmonare)

Segno indiretto di ipertensione polmonare



**ACT <100 msec - ACT <80 msec (più specifico)**

Valore normale del tempo di accelerazione polmonare = 137 +/- 24 msec

# SEGNO del 60/60

Elevata impedenza vascolare/Incremento contenuto della PAPs

Tempo di Accelerazione polmonare nel RVOT < 60 msec

Insufficienza tricuspидale con gradiente VA destro < 60 mmHg

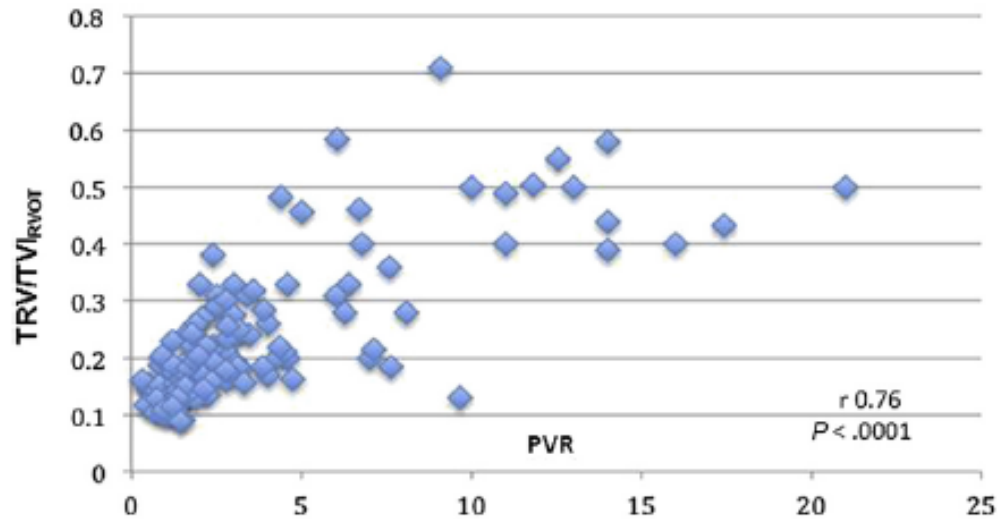
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# SEGNO di Mc Connell

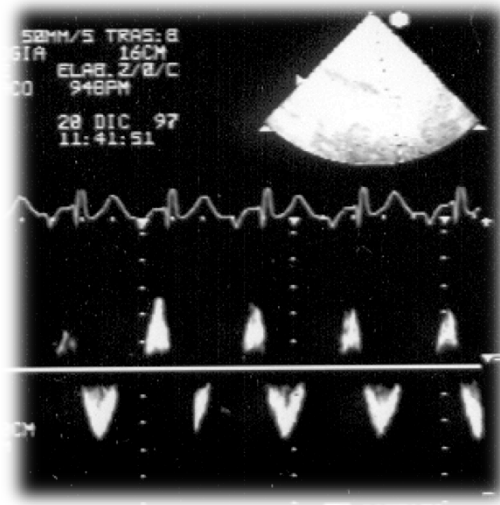
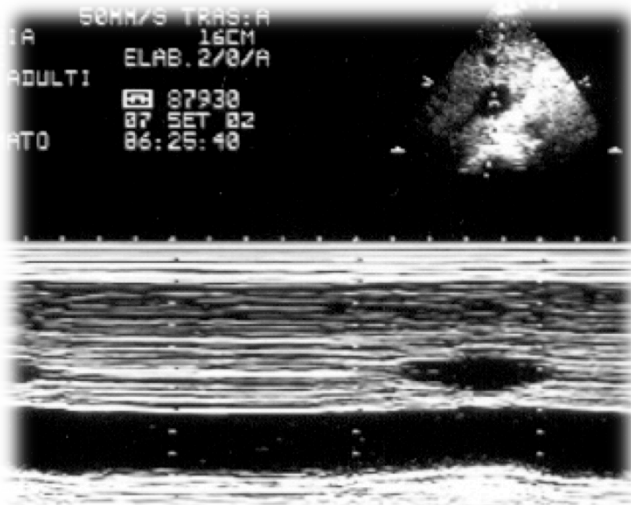
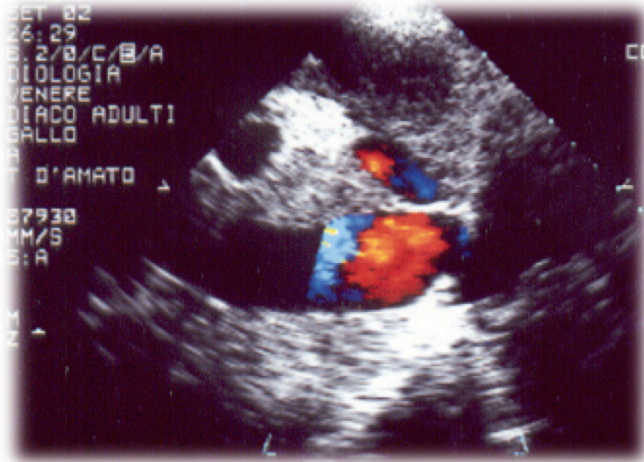
Pattern distintivo di dissinergia del ventricolo destro

# Noninvasive Assessment of Pulmonary Vascular Resistance by Doppler Echocardiography

$$\text{PVR (WU)} = \text{TRV}/\text{TVI}_{\text{RVOT}} \times 10$$



# Dilatazione e congestione della VCI

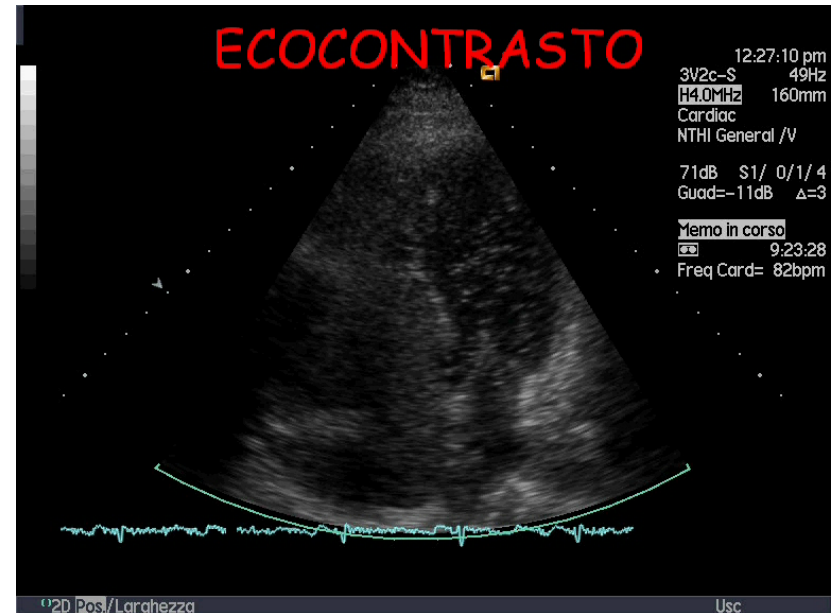




# Fisiopatologia nell'EP Acuta

Alterato rapporto ventilazione-perfusione:

- aumento dello spazio morto
- riduzione dei volumi respiratori
- apertura di shunt artero-venosi polmonari

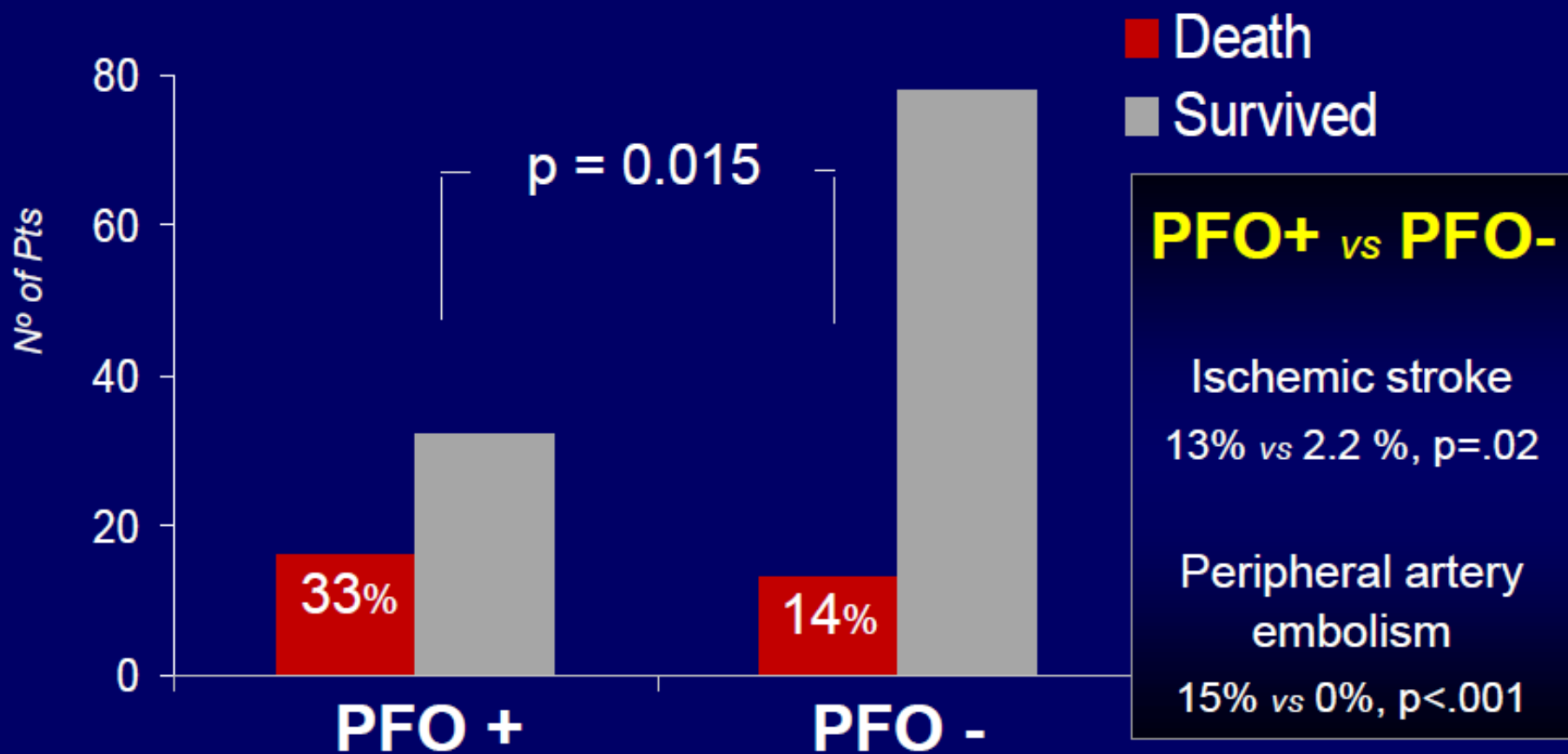


L'aumento della pressione atriale destra può, a volte, generare shunt destro-sinistro attraverso un PFO (forame ovale pervio), possibile tramite per embolie paradosse.

# 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%)



# Ecocardiografia nel monitoraggio degli effetti della terapia della EP acuta

- Recupero della contrattilità del ventricolo destro
  - Normalizzazione del flusso polmonare
  - Riduzione della pressione polmonare
  - Scomparsa dei trombi

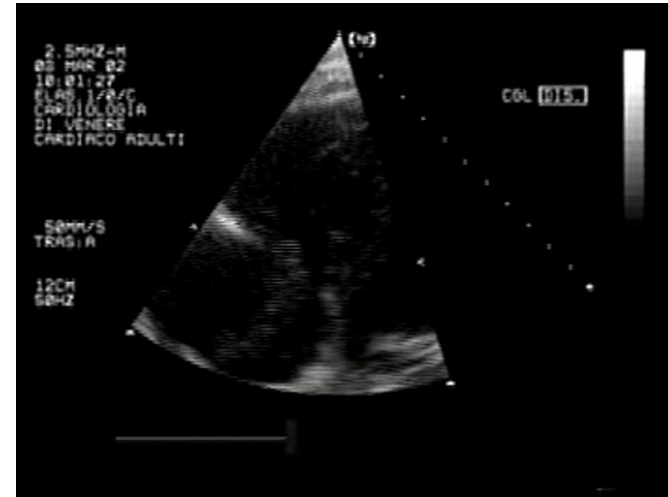


# Ecocardiogramma TTE Caso Clinico

1



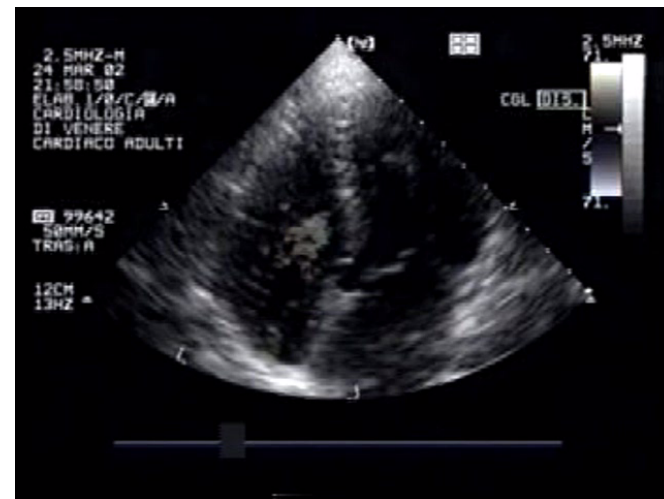
2



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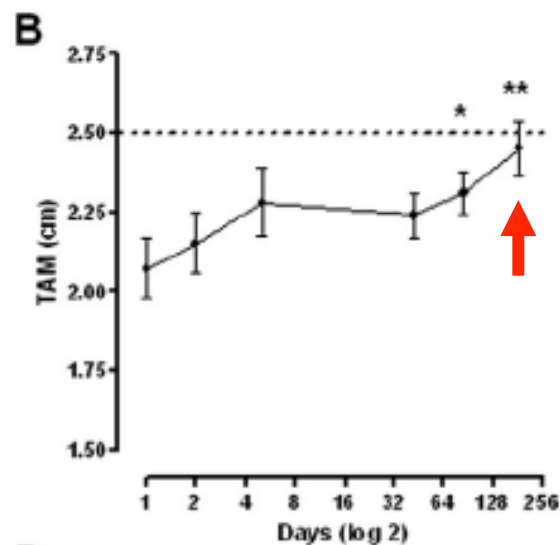
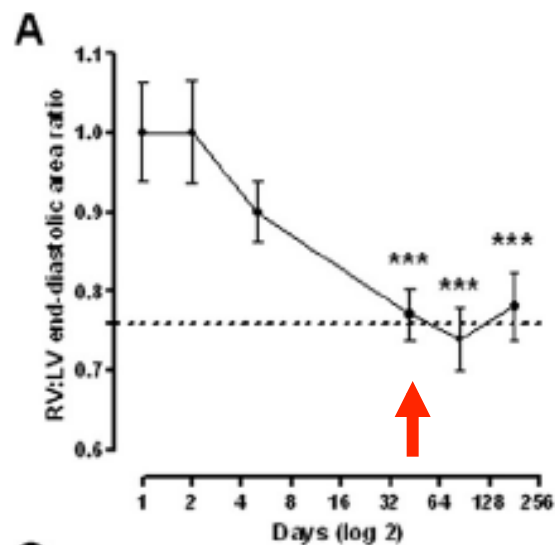


# Follow up dell'embolia polmonare

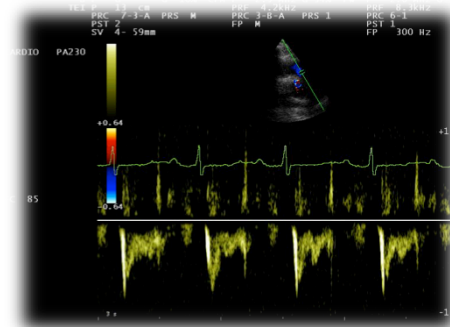
Le misure ecocardiografiche forniscono un prezioso monitoraggio del recupero funzionale del VD dopo EP Acuta.

✓ Più precoce è il rimodellamento inverso (30-60 gg.).

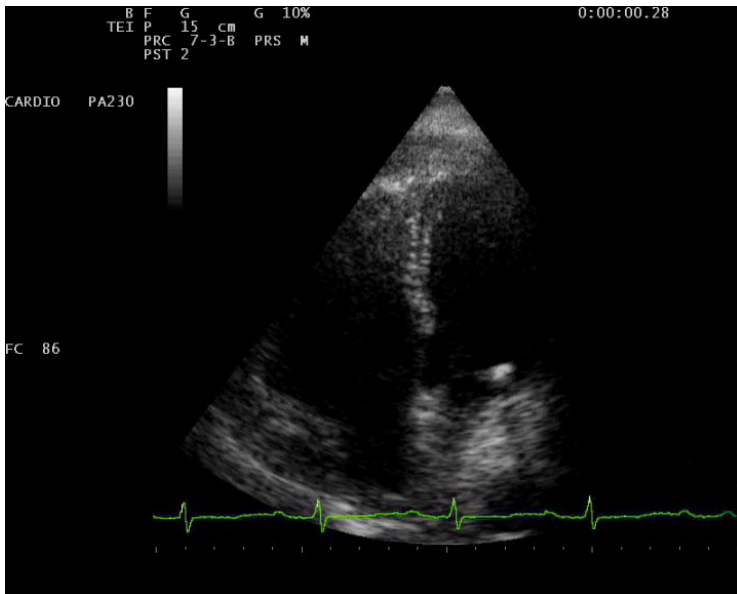
✓ Più tardivo il completo recupero dell'accorciamento base-punta (180-250 gg.).



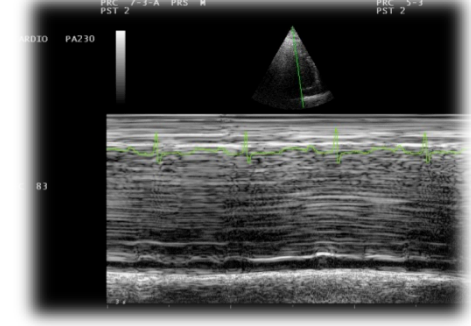
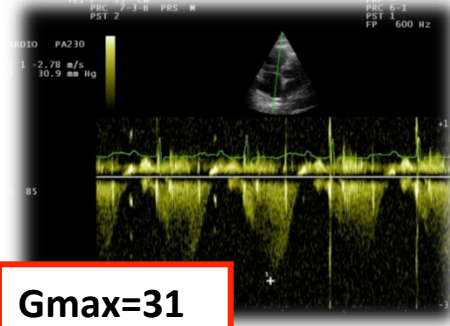
# Caso Clínico EP

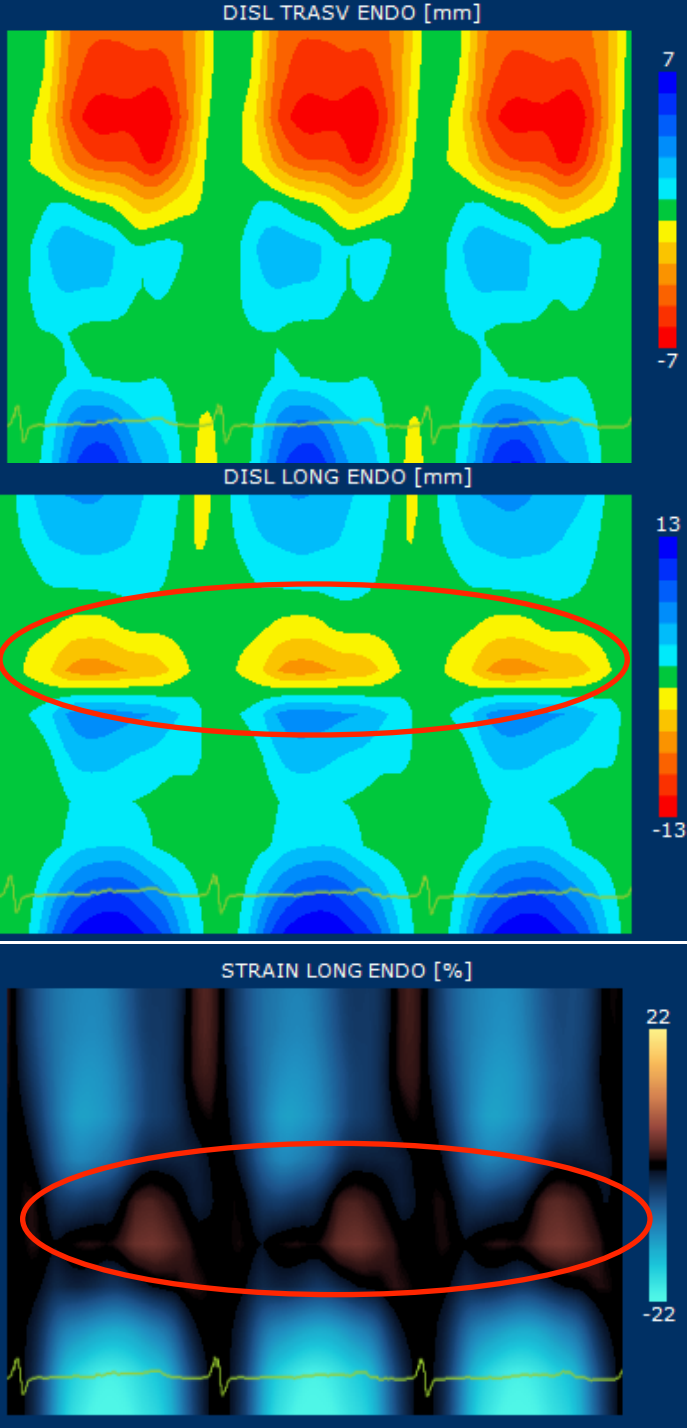


**TAPSE=16**

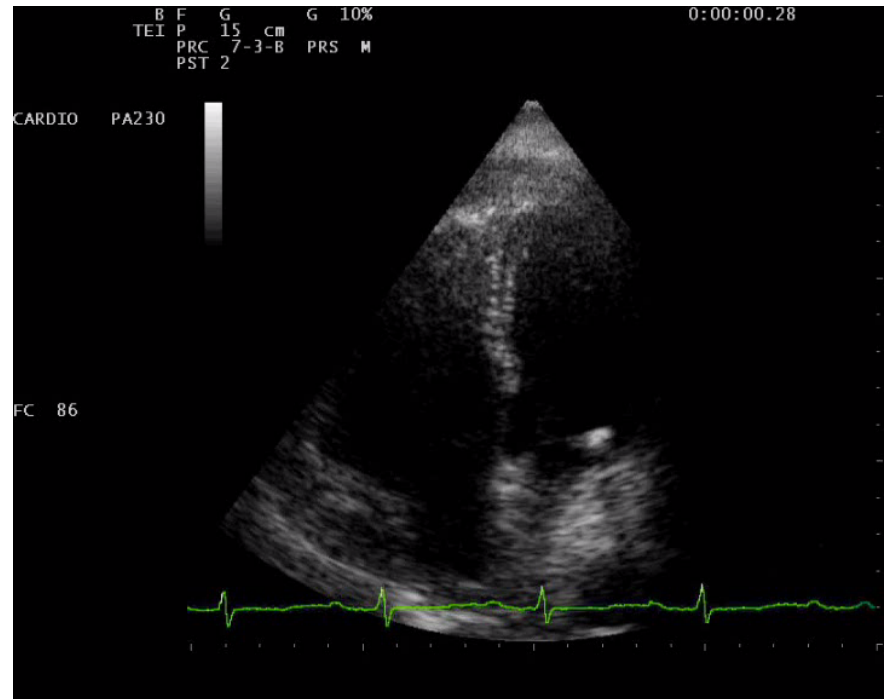
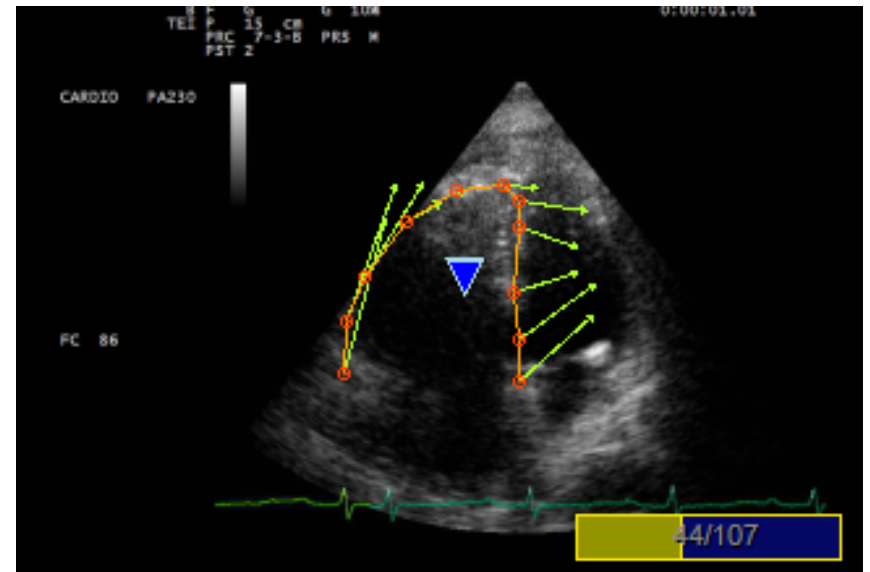


**Gmax=31**





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# Metodi di valutazione del Ventricolo Destro

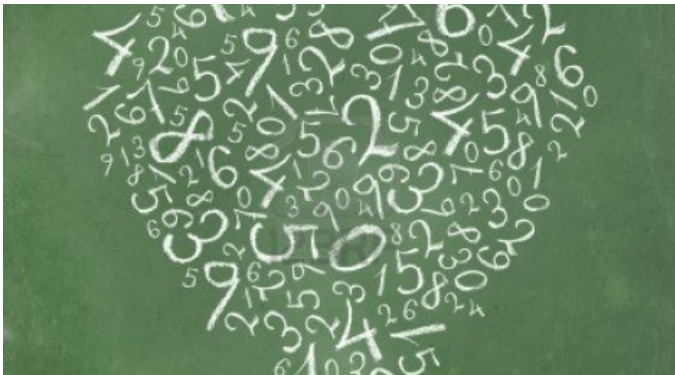
**Metodo soggettivo** (giudizio qualitativo)



**Vecchi metodi quantitativi:**

M - diametri, spessore, TAPSE,  
2D - diametri, spessore, FAC, EF  
Doppler – dP/dT, TEI index, PAP

**Nuovi metodi quantitativi:**

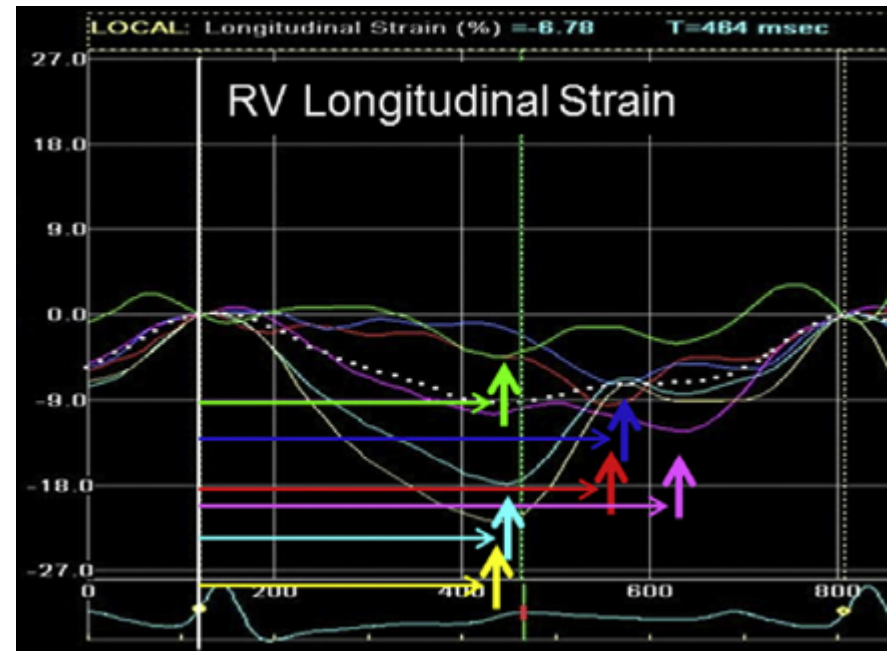
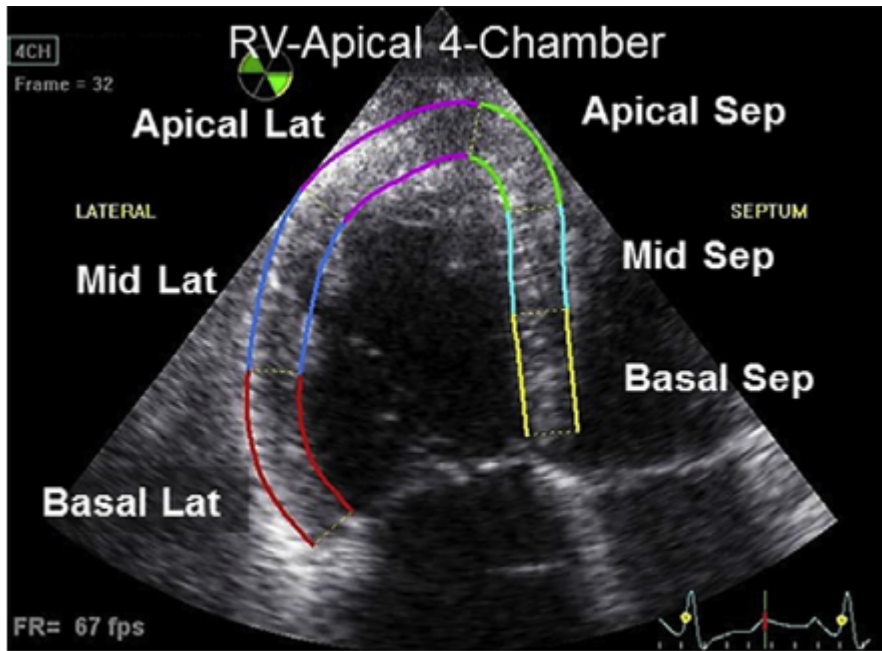


TDI - Velocità S', Diastole E/E', IVA,  
IVRT, TEI index, Strain Imaging  
Speckle Tracking: Strain – strain-rate

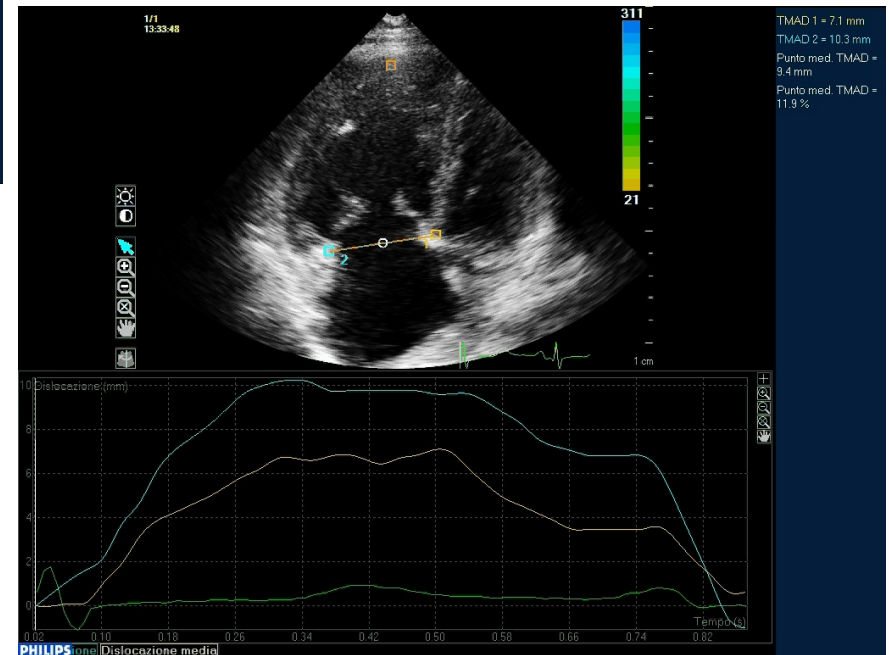
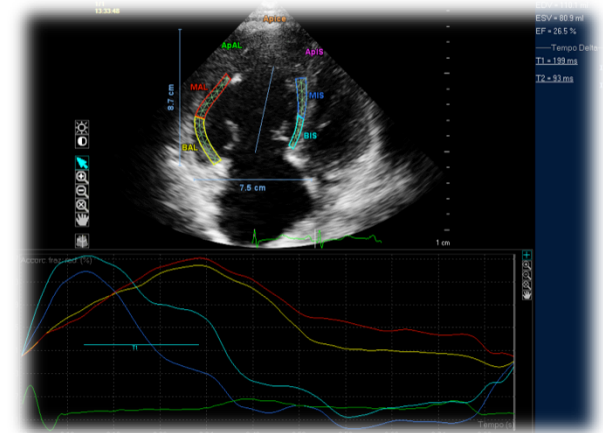
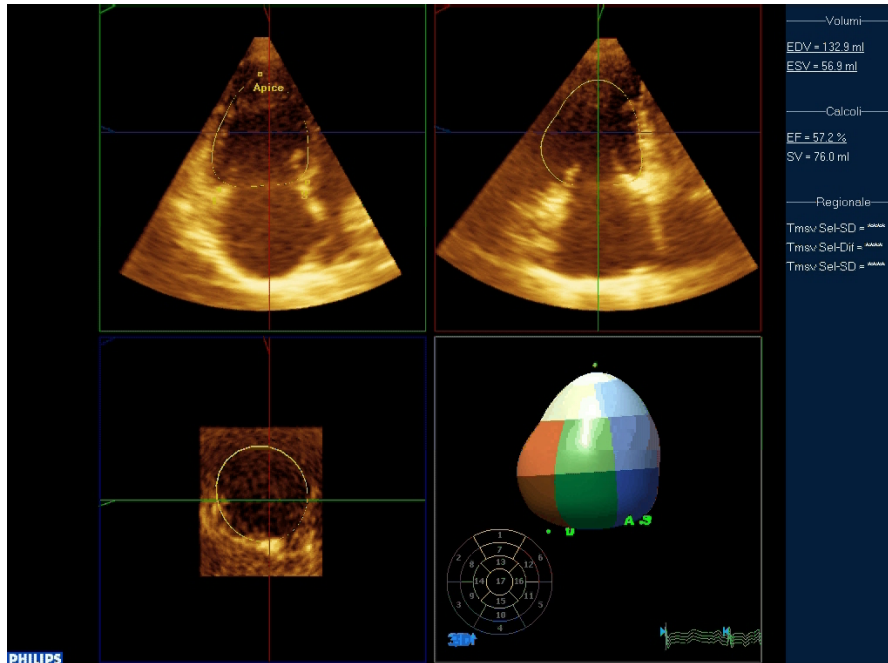
3DE: Volumi, EF, forma e massa



# Ventricular Function and Dyssynchrony Quantified by Speckle-Tracking Echocardiography in Patients with Acute and Chronic Right Ventricular Pressure Overload

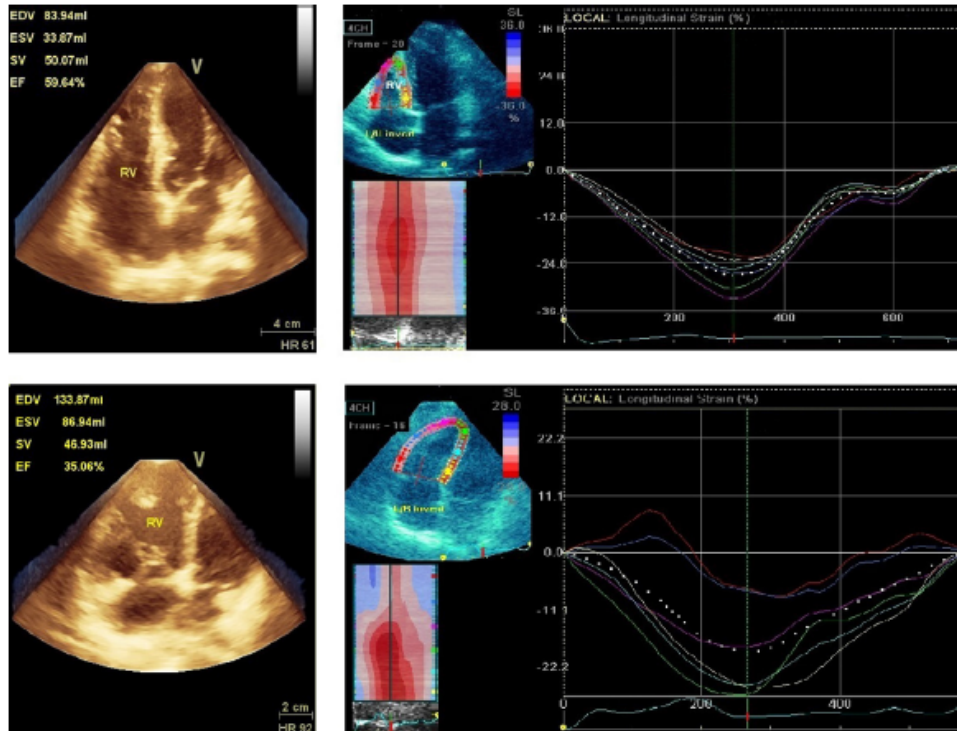


# 3DRT per lo studio del ventricolo destro

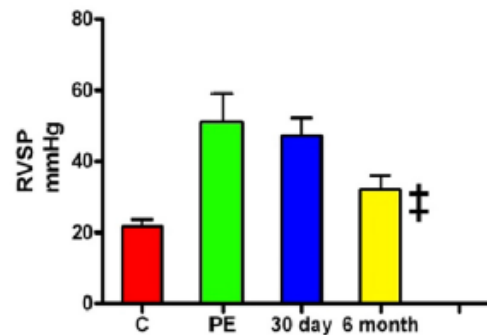
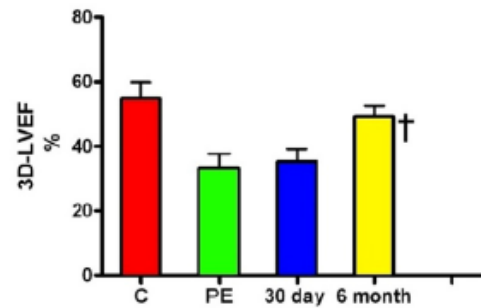
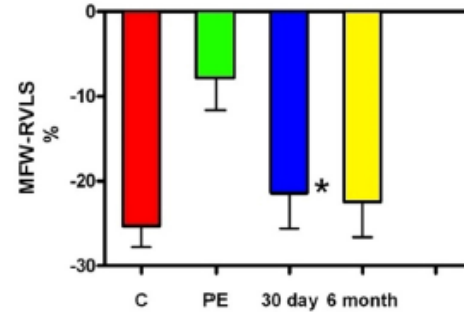
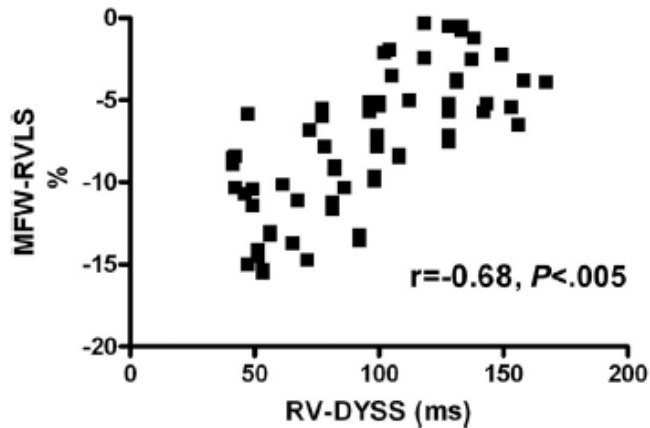
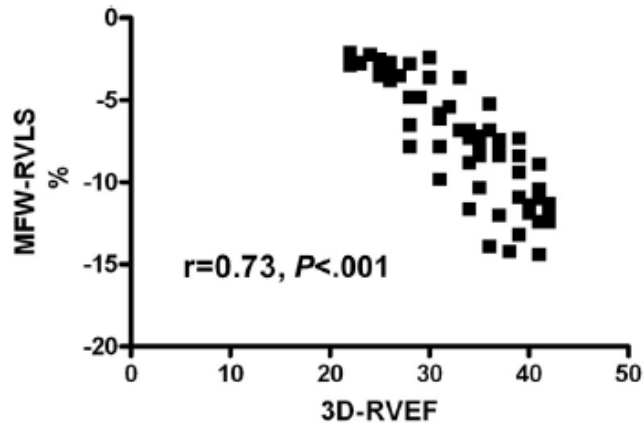


# Right Ventricular Function in Acute Pulmonary Embolism: A Combined Assessment by Three-Dimensional and Speckle-Tracking Echocardiography

Three-dimensional (3D) echocardiography and speckle-tracking echocardiography in patients with acute pulmonary embolism and RV dysfunction without systemic hypotension (submassive pulmonary embolism).



# Right Ventricular Function in Acute Pulmonary Embolism: A Combined Assessment by Three-Dimensional and Speckle-Tracking Echocardiography

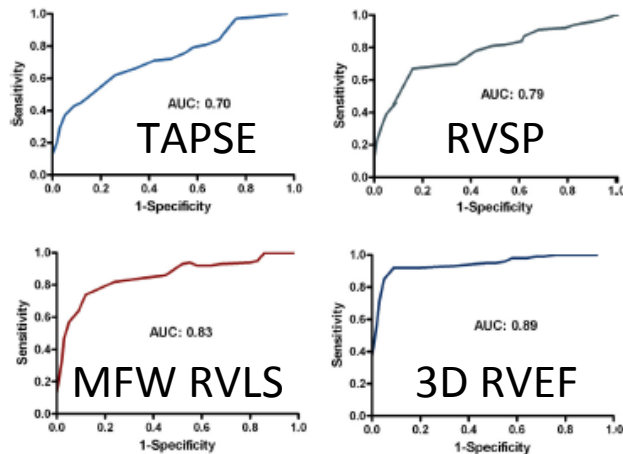


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**Table 4** Results of receiver operating characteristic curve analysis comparing different echocardiographic parameters for the accuracy to predict unfavorable outcomes after 6-month follow-up

Parameter	AUC	95% CI	P	Cutoff	Sensitivity (%)	Specificity (%)
PAT	0.69	0.57–0.93	.09	83 msec	70	62
TAPSE	0.70	0.51–0.96	.07	13 mm	72	65
RV FAC	0.71	0.52–0.96	.08	37%	73	64
RV/LV ratio	0.76	0.49–0.92	.07	1.05	74	69
Global RVLS	0.77	0.63–0.82	.06	–19%	77	67
RVSP	0.79	0.62–0.94	.05	43 mm Hg	79	68
MFW RVLS	0.83	0.64–0.88	.03	–12%	84	74
3D RVEF	0.89	0.72–0.98	.02	40%	88	79

AUC, Area under the curve; CI, confidence interval; PAT, pulmonary acceleration time.



**Table 3** Results of univariate and multivariate Cox proportional-hazards analysis of the relation between clinical variables and 6-month adverse outcomes

Variable	HR	95% CI	P
<b>Univariate analysis</b>			
Age	1.99	1.54–2.91	.005
SBP	1.92	1.77–2.71	.025
Diabetes mellitus	1.16	1.01–1.76	.014
Sepsis	1.21	1.08–1.83	.019
Renal insufficiency	1.93	1.67–2.82	.037
Troponin I	2.07	1.15–3.24	<.001
RVSP	2.19	2.17–3.46	.002
RV/LV ratio	1.22	1.08–1.74	.004
TAPSE	1.74	1.53–2.86	<.05
RV FAC	1.98	1.63–2.95	<.01
MFW RVLS	2.27	1.49–3.92	<.0005
3D RVEF	4.32	2.43–8.09	<.0001
<b>Multivariate analysis</b>			
Troponin I	1.93	0.91–2.79	.008
RVSP	2.14	1.12–2.91	.007
MFW RVLS	2.95	1.31–3.23	.002
3D RVEF	3.51	1.66–4.51	.001

# CONCLUSIONI

L'ecocardiografia avanzata quantitativa STE e 3D del ventricolo destro consente di andare più in profondità nella comprensione della funzione ventricolare in corso di embolia polmonare, ben oltre la stima della pressione polmonare.

Il perfezionamento della metodica e l'impiego di nuovi software può agevolarne l'uso nella pratica clinica.

Studi clinici più ampi che ne facciano uso potranno migliorare il trattamento dei pazienti con embolia polmonare acuta.