Echocardiography of the Right Ventricle

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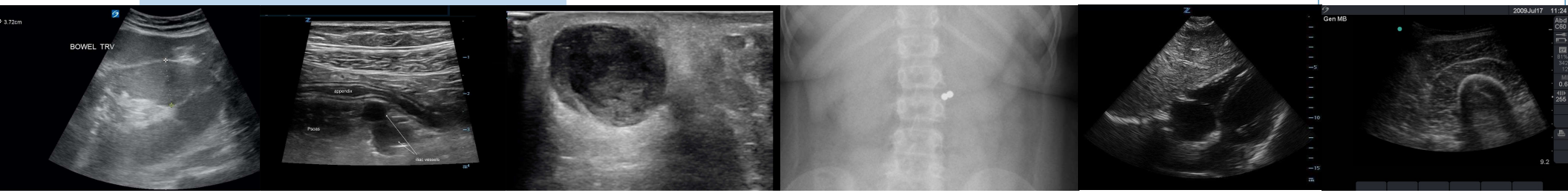
Stephen Alerhand MD

January 2024



I have no disclosures to report

Why care about RV dysfunction?

Acute Pulmonary Embolism	Chronic Pulmonary Hypertension
Expedite CTPE	Make ED dx when LV function normal
Lytics in high-risk PE or s/p ROSC	High-flow O_2 instead of NIPPV
Rule out high-risk PE	Sedation with Ketamine over Propofol
Risk-stratify diagnosed PE's	Hold IVF and start vasopressors
Monitor response to interventions	Monitor response to interventions

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Increased RV:LV Size Ratio

PE
Sensitivity 55%
Specificity 86%

↑ sensitivity with higher-risk PE's

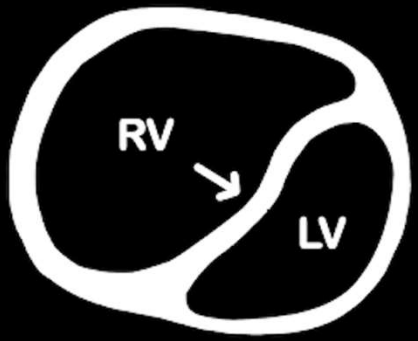
Normal 0.67:1

Moderately dilated 1:1 - 1.5:1

Severely dilated > 1.5:1

Abnormal Septal Motion

PE
Sensitivity 26%
Specificity 95%



↑ sensitivity with higher-risk PE's

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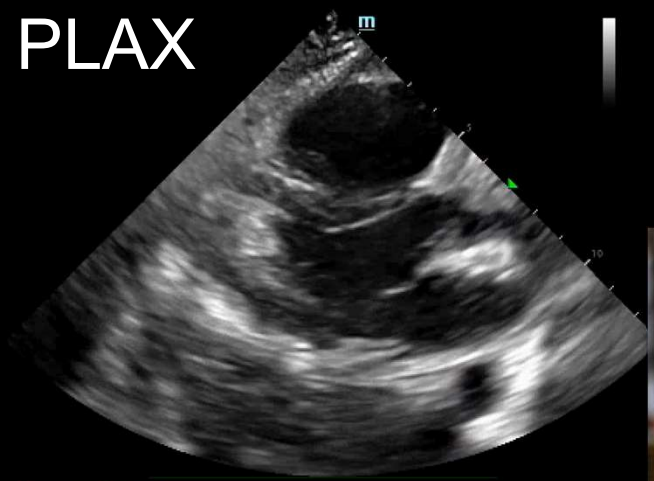
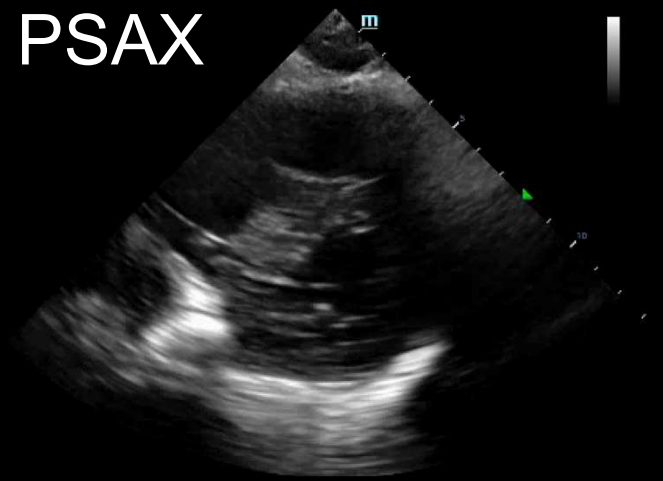
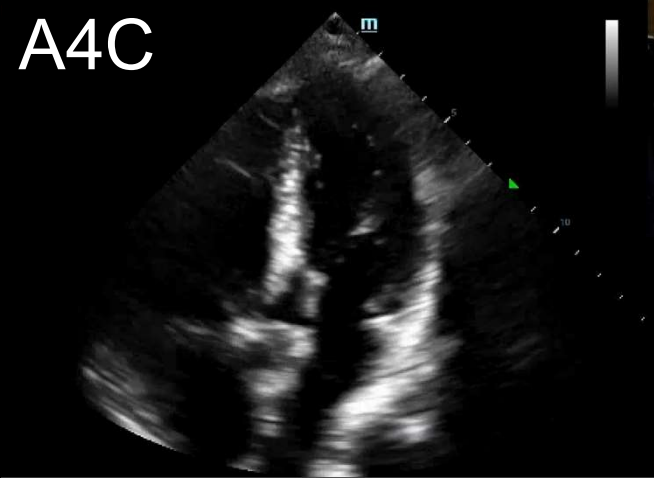
PLAX



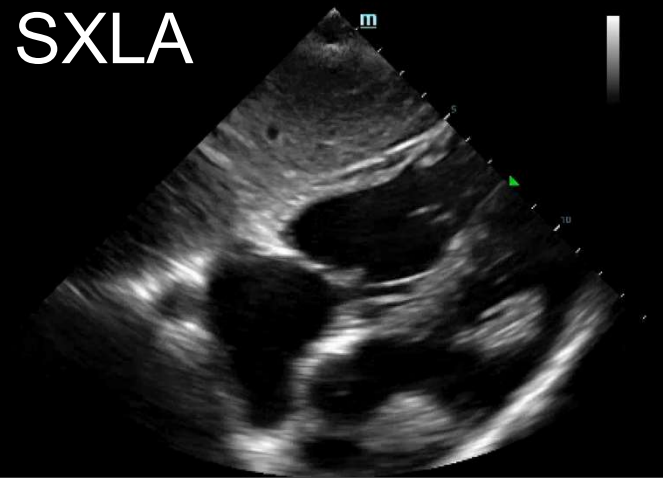
PSAX



A4C



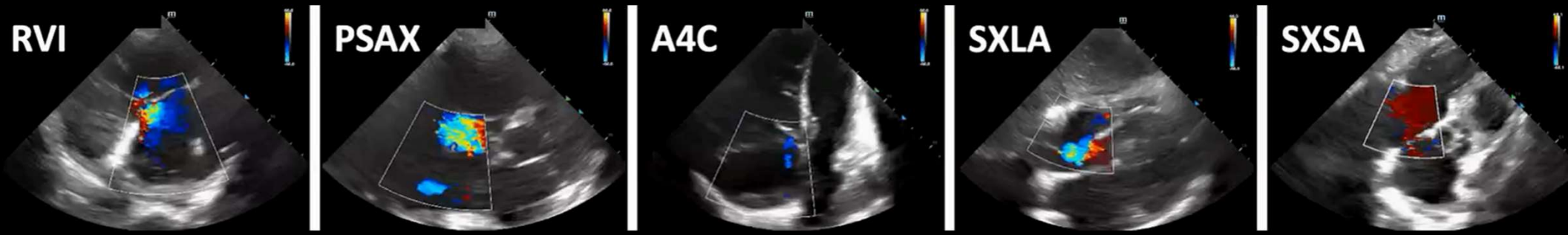
SXLA



Tricuspid Regurgitation

PE
Sensitivity 40%
Specificity 83%

25-40% of patients with elevated PAP do not demonstrate a jet



Doppler shift $\propto \cos\theta$

θ: angle between emitted sound waves and blood flow

cos 0° = 1 cos 10° = 0.98 cos 20° = 0.94 cos 30° = 0.87 cos 40° = 0.77

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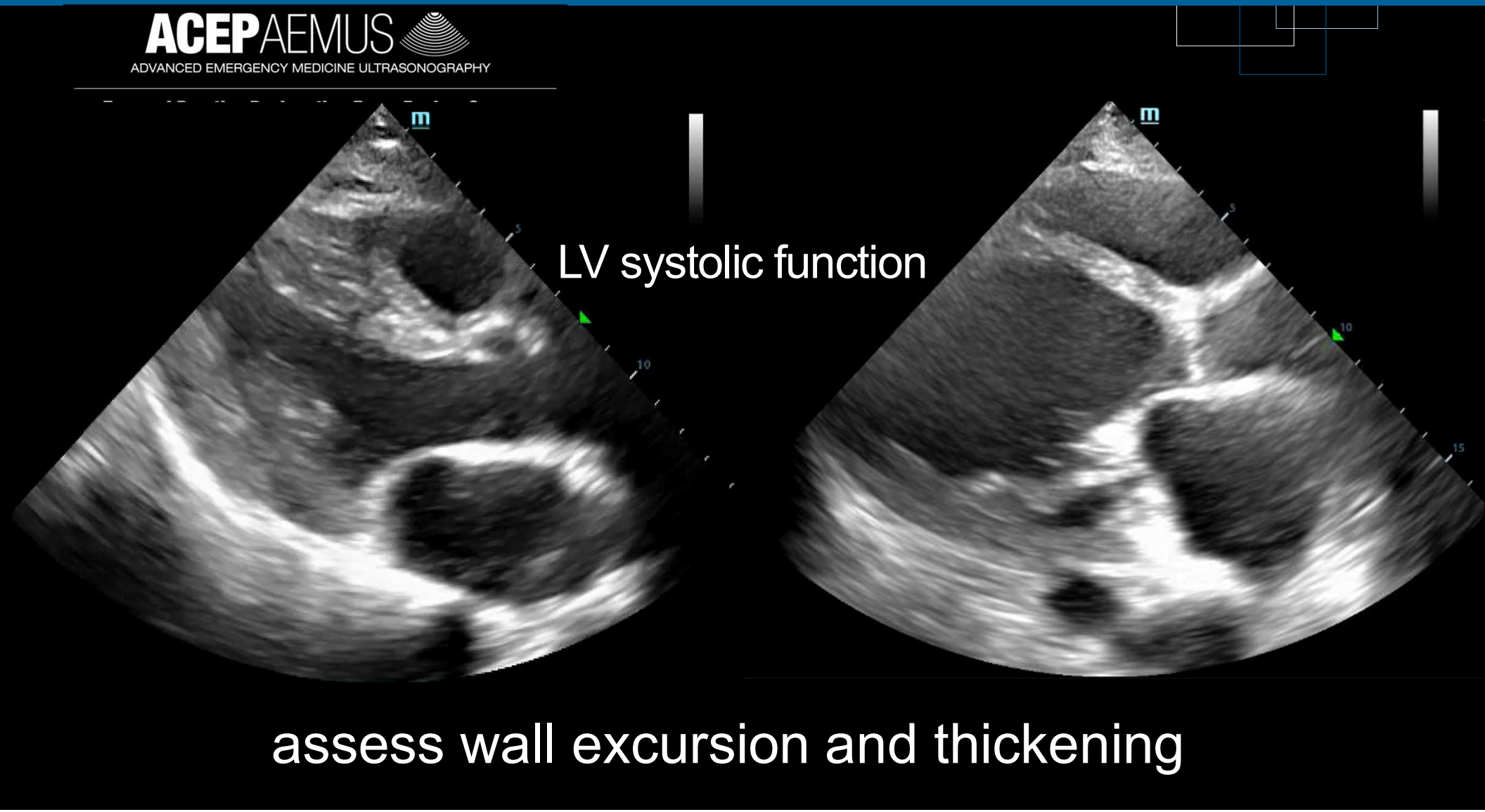
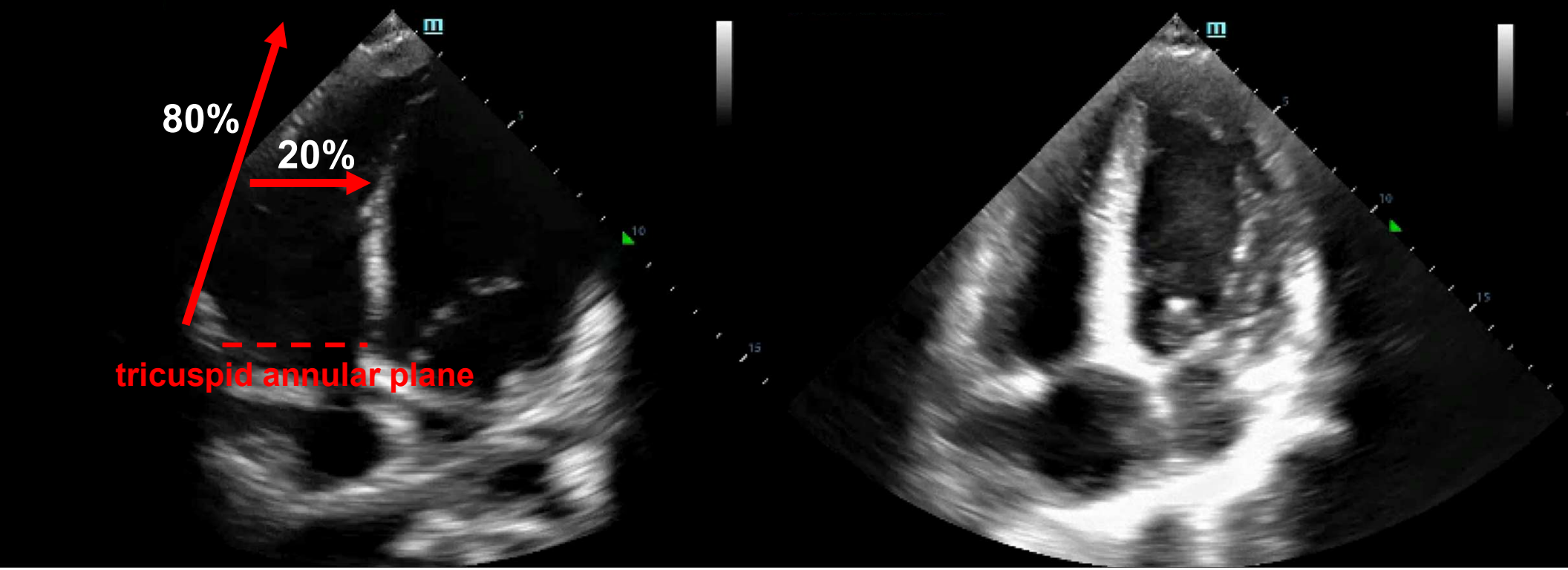


assess wall excursion and thickening

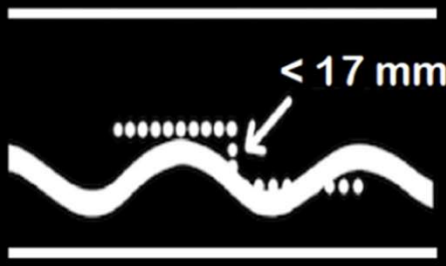
RV systolic function is 80% longitudinal and 20% circumferential



Decreased TAPSE

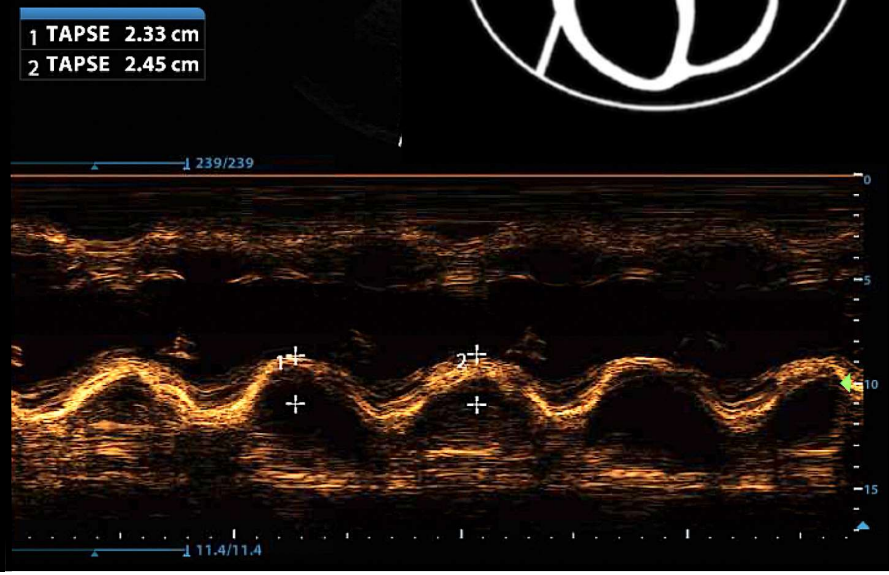
(tricuspid annular plane systolic excursion)

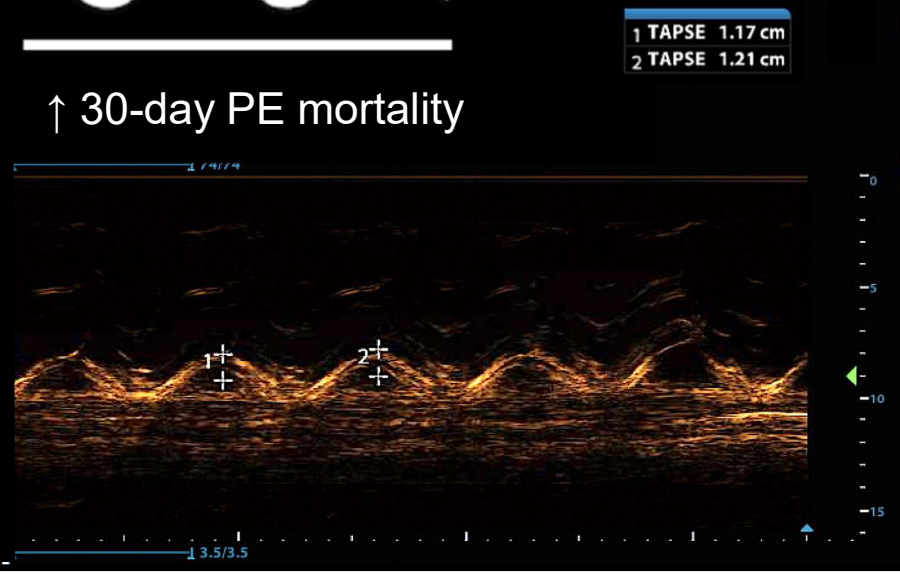
PE
Sensitivity 66-77%
Specificity 85%
HR ≥ 100 bpm
SBP < 90 mmHg



(mean 24 mm)

↑ 30-day PE mortality





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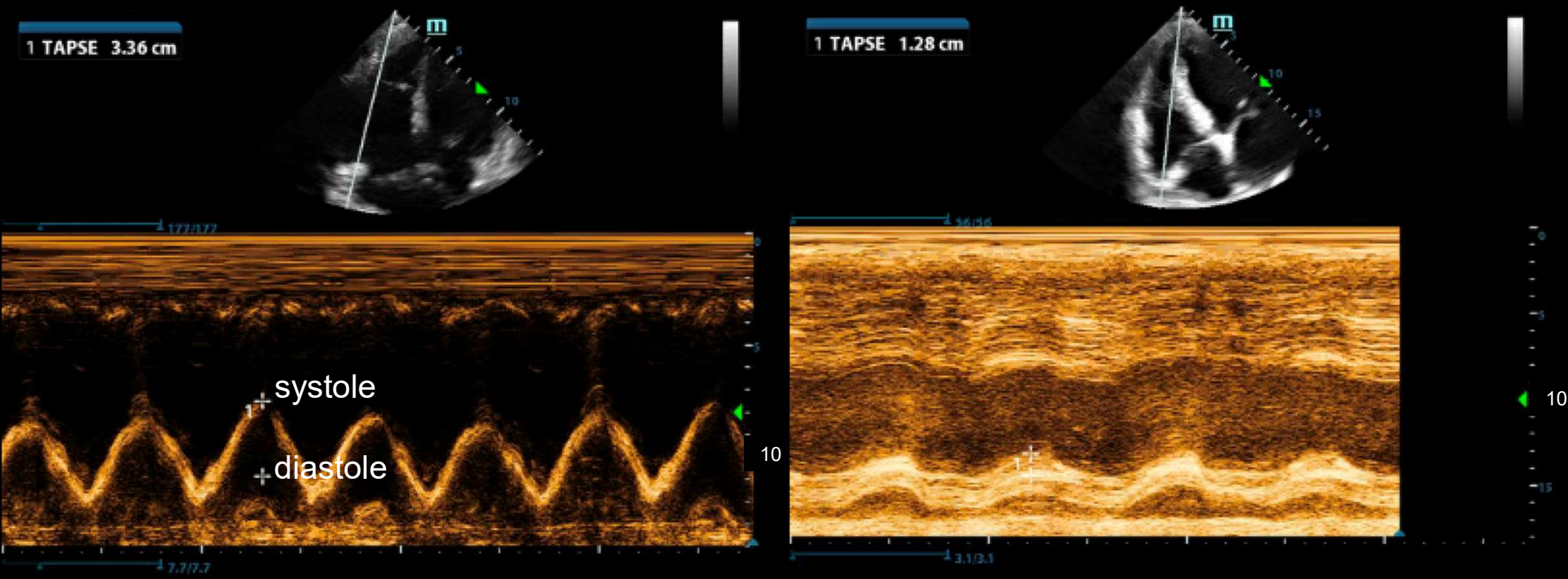
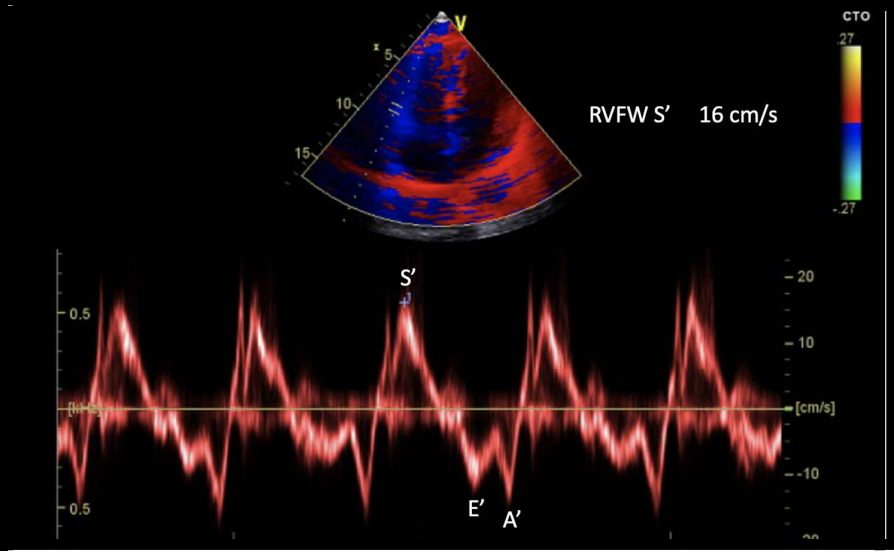


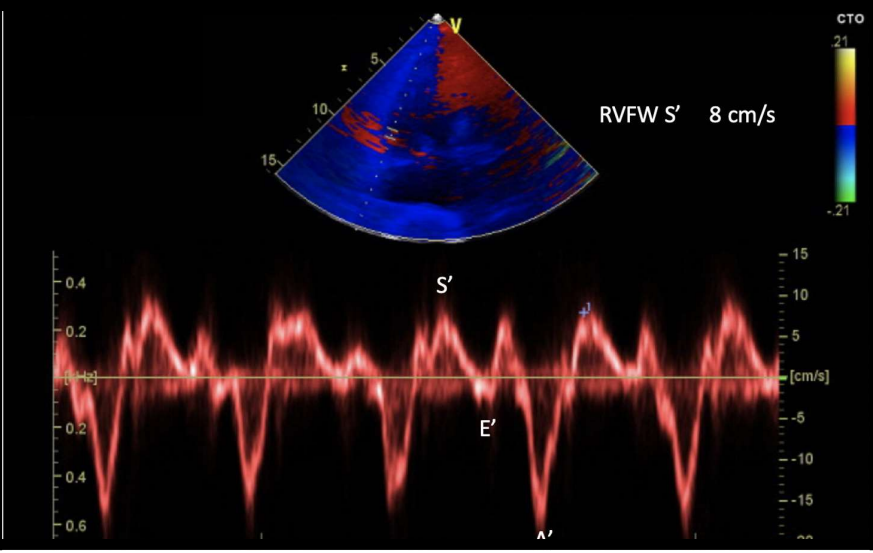
pro-tip: decrease depth

Decreased S'

RVEF < 30%
S' < 9 cm/s
Sensitivity 82-83%
Specificity 68-86%

(mean 14.4 cm/s)





Which of the following correctly describes how to estimate the TRPG and/or PASP?

A. A dilated, non-collapsible inferior vena cava corresponds to an estimated right atrial pressure of 15 mmHg.

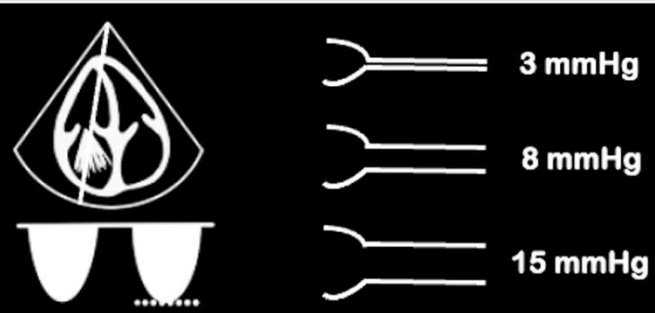
B. A larger angle between emitted sound waves and regurgitant flow leads to an overestimated TRPG/PASP.

C. Pulsed wave Doppler is used to obtain the TRV_{max} from the TR Doppler waveform.

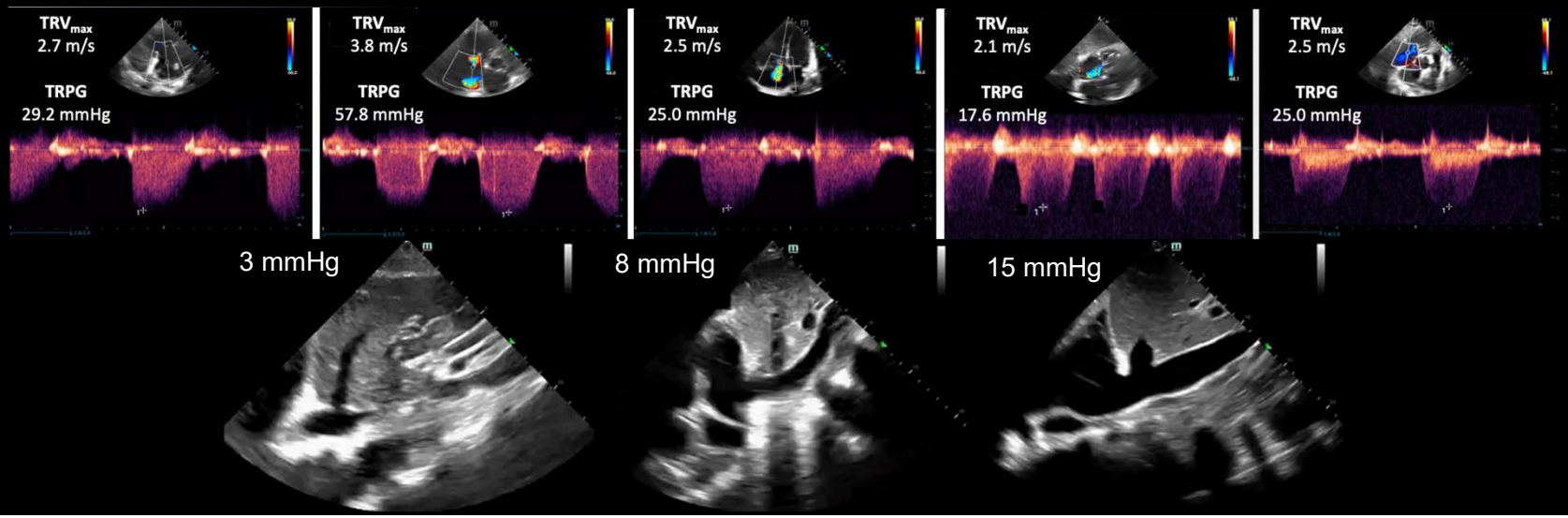
D. Tricuspid regurgitation can be obtained from the parasternal short-axis and apical 4-chamber views only.

Elevated Pulmonary Artery Systolic Pressure

$\Delta P_{RV\text{-}RA} = TRPG = 4 \times TRV_{max}^2$



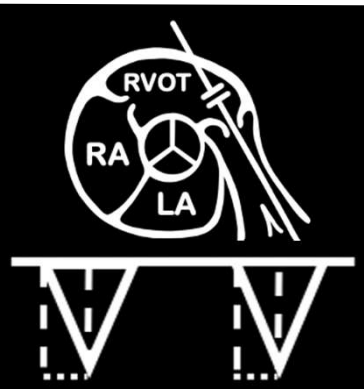
PASP = (4 x TRV_{max}^2) + RAP > 35 mmHg (normal TRV_{max} 2.0-2.1 m/s; TRPG 16.0-18.3 mmHg)



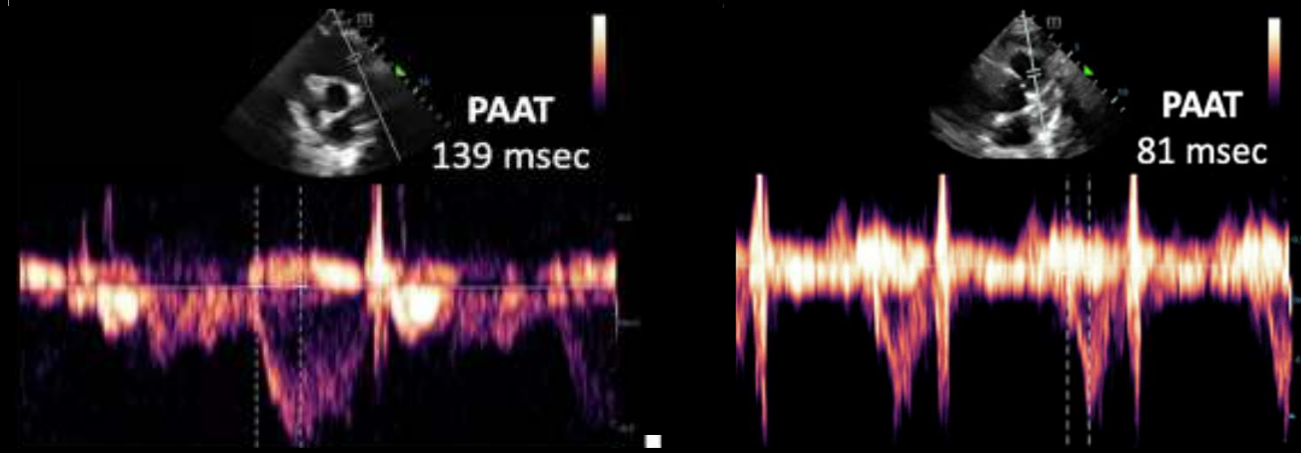
PE
Sensitivity 44%
Specificity 84%

Decreased Pulmonary Artery Acceleration Time

Associated with increased PA pressure

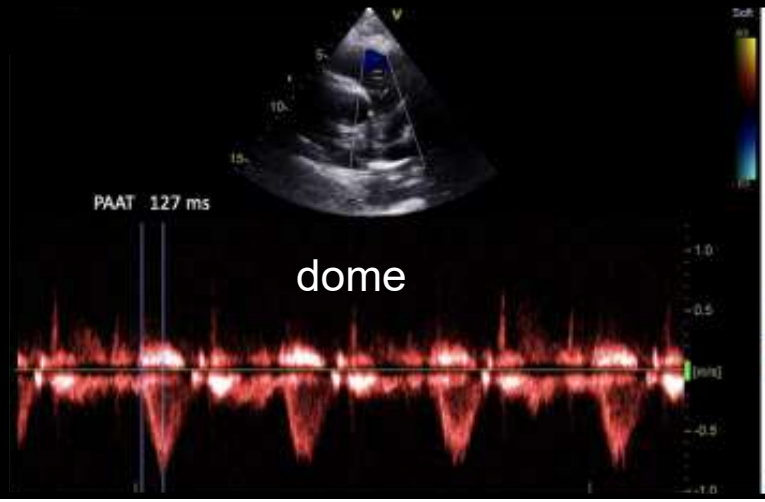


< 105 msec (normal 156-153 msec)

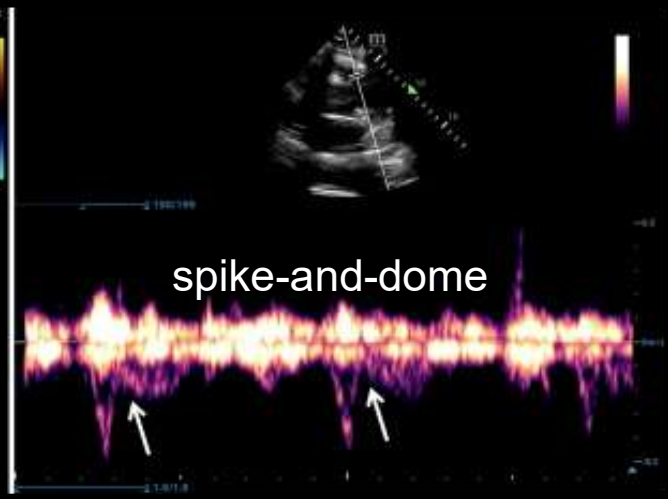


Pulmonary Artery Mid-Systolic Notching

↑ sensitivity with higher-risk PE's



dome



spike-and-dome

Why care about acute vs chronic RV dysfunction?

Hold lytics and avoid risk of bleeding in patients without PE

e.g. hemodynamic instability, s/p ROSC

Not order CTPA every time PH patient reports dyspnea

Avoid time delays and unnecessary ionizing radiation

Understand pathophysiology, guide time-sensitive management, gauge response to therapies

Which echocardiographic finding is most specific to acute right ventricular dysfunction?

A. RV:LV size ratio > 1:1

B. Septal dyskinesia

C. Pulmonary artery acceleration time 80 msec

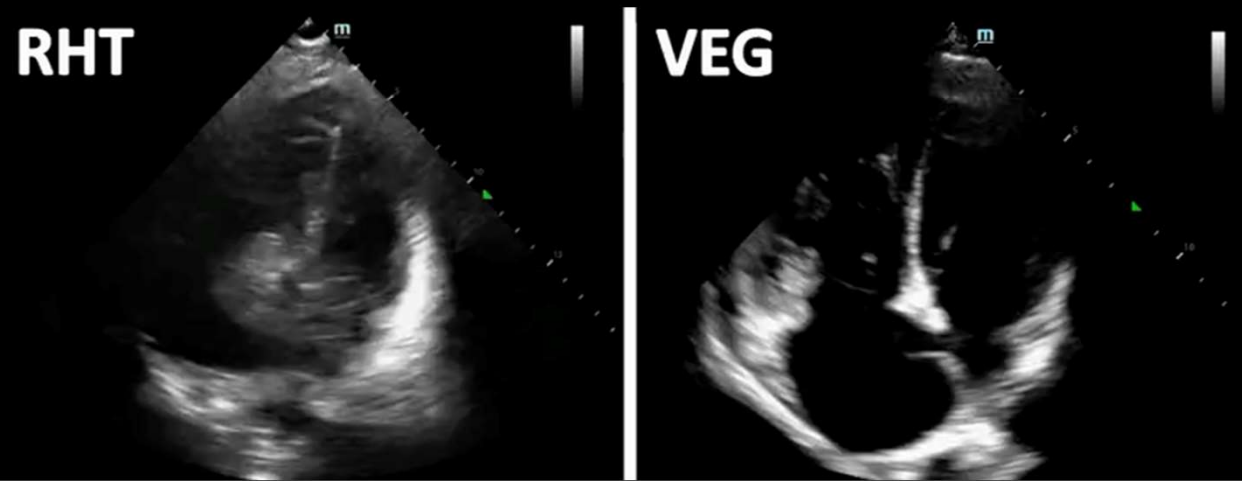
D. Pulmonary artery early-systolic notching

Right Heart Thrombus

Acute

Sensitivity	5%
Specificity	99%

Prevalence	1.8-8.7%
Unstable/ICU	16-19%



Which echocardiographic finding is most specific to chronic right ventricular dysfunction?

A. Right ventricular free wall thickness 3.7 mm

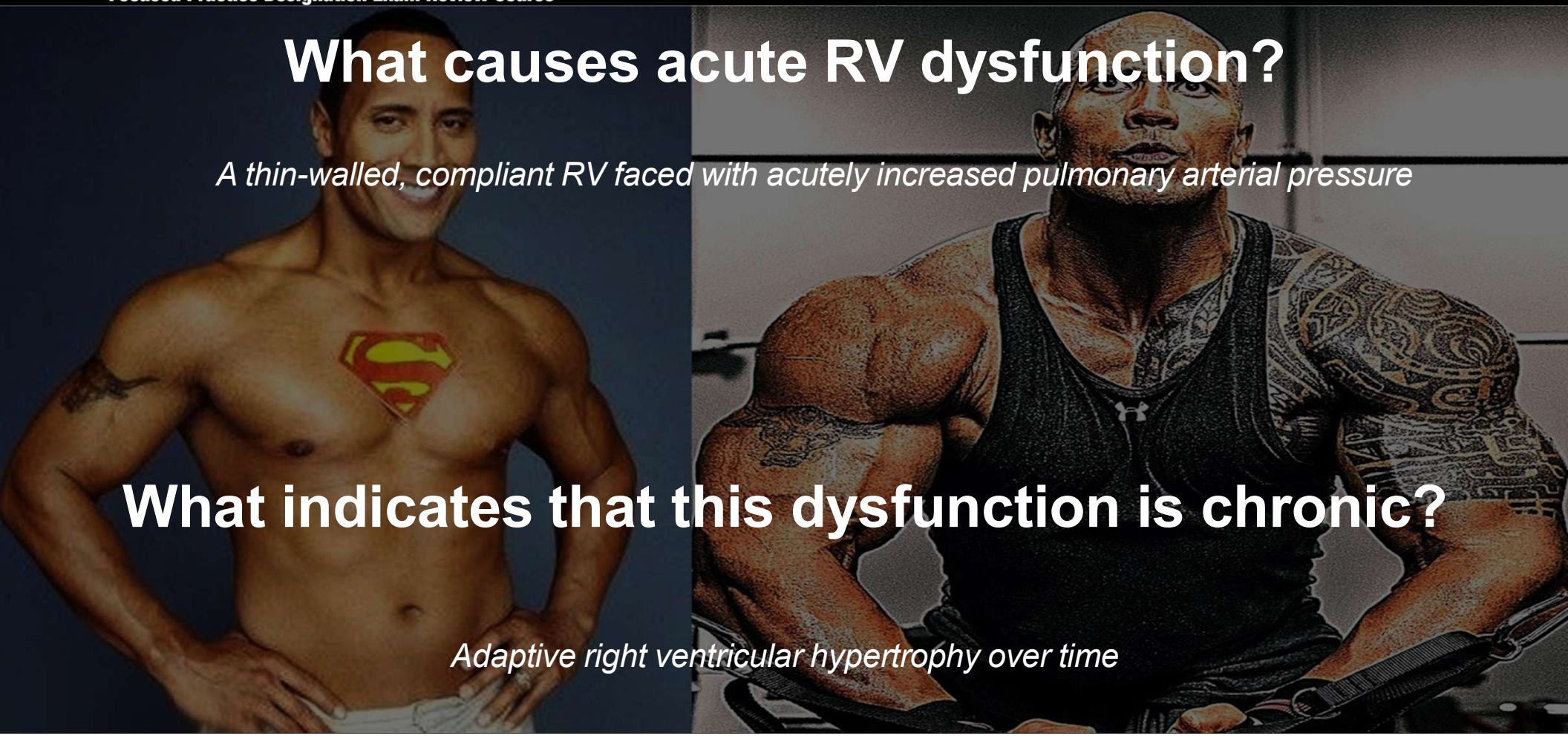
B. S' 11 cm/s

C. TAPSE 15 mm

D. TRPG 62 mmHg

What causes acute RV dysfunction?

A thin-walled, compliant RV faced with acutely increased pulmonary arterial pressure



What indicates that this dysfunction is chronic?

Adaptive right ventricular hypertrophy over time

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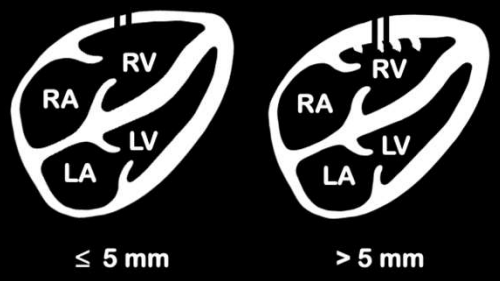
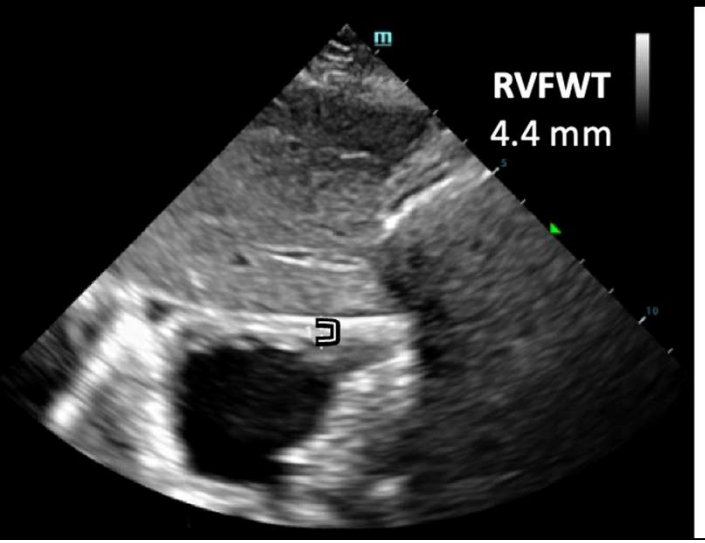
RVH
Sensitivity 92%
Specificity 94%

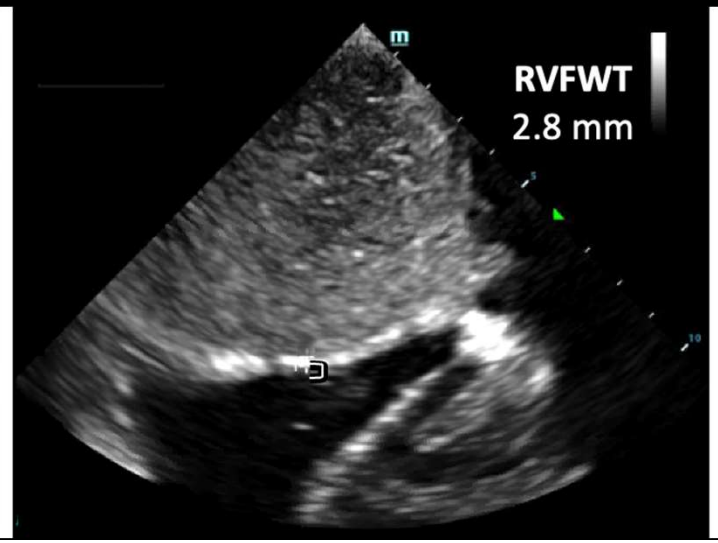
Right Ventricular Free Wall Thickness

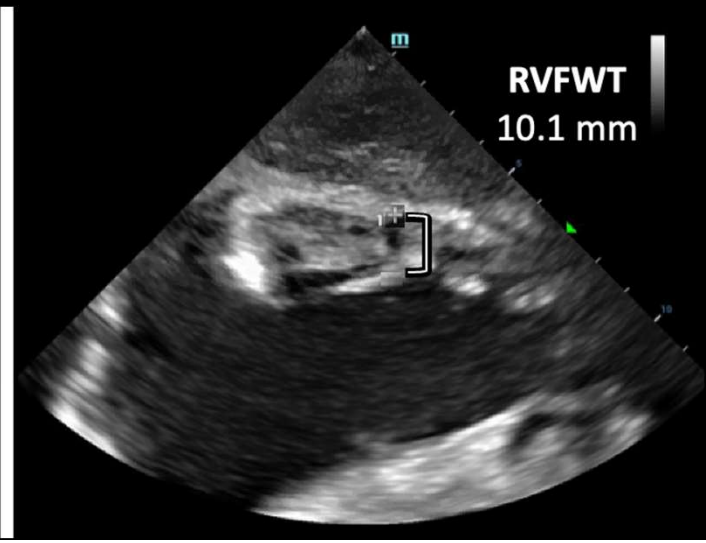


↓ mortality in PH

$$\text{wall stress} \propto \frac{p \times r}{h}$$







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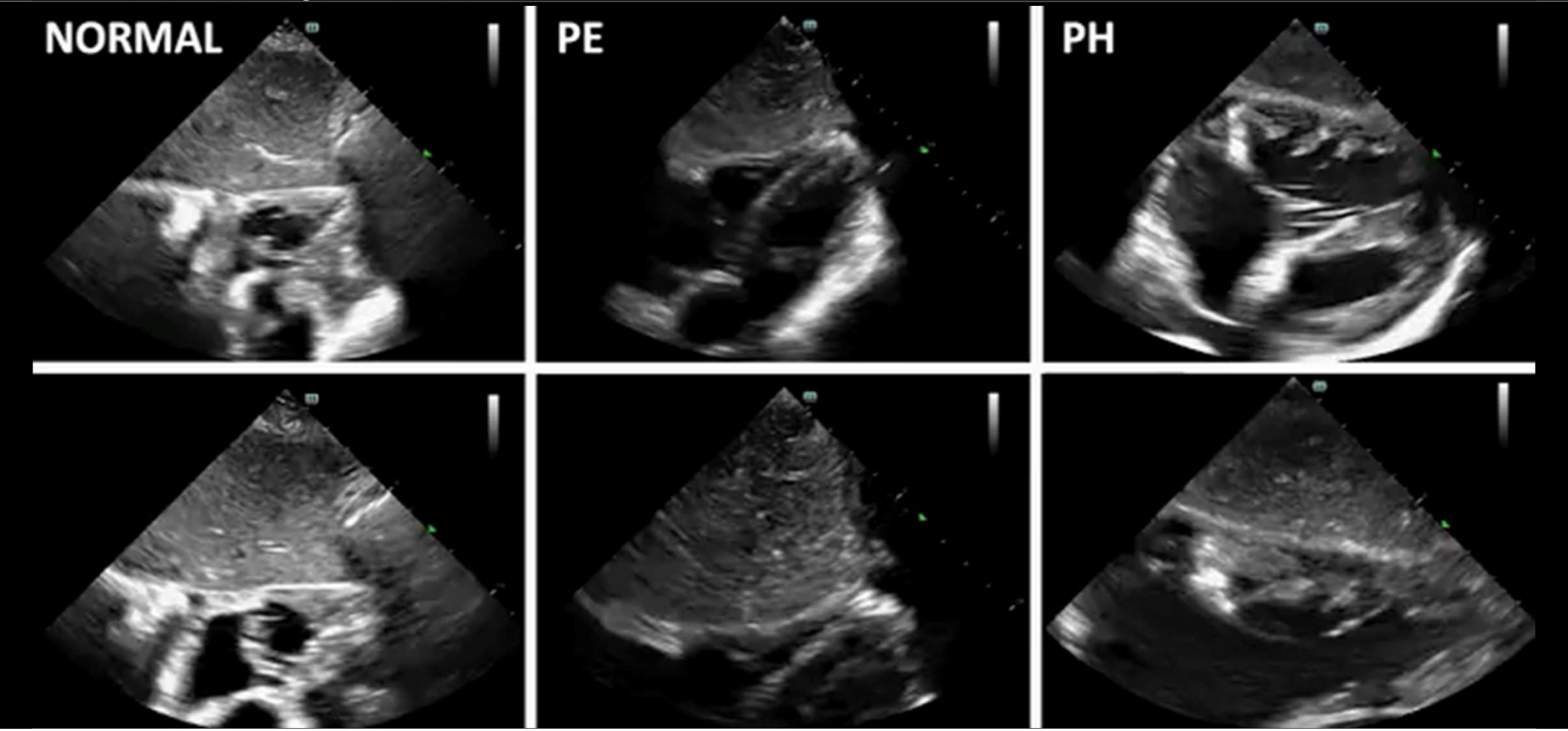

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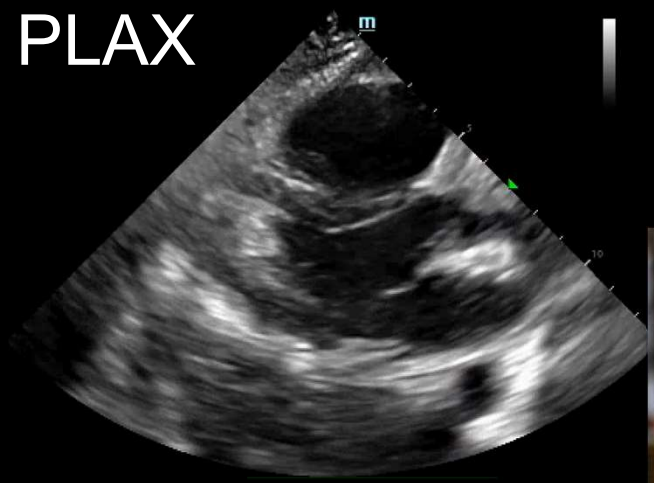

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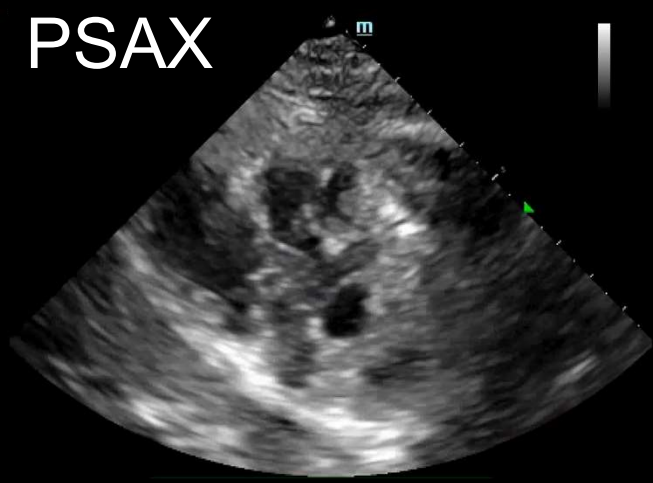
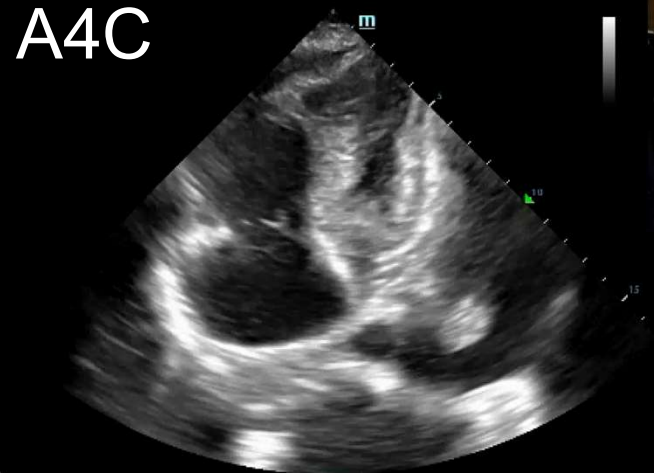
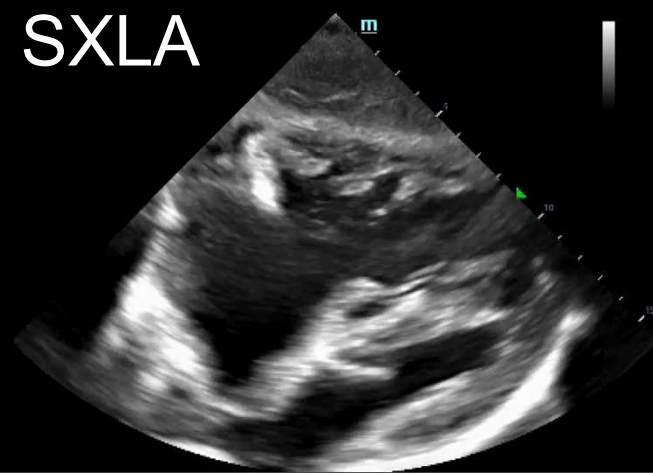


A4C



SXLA



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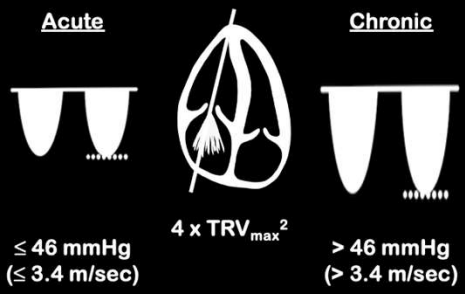
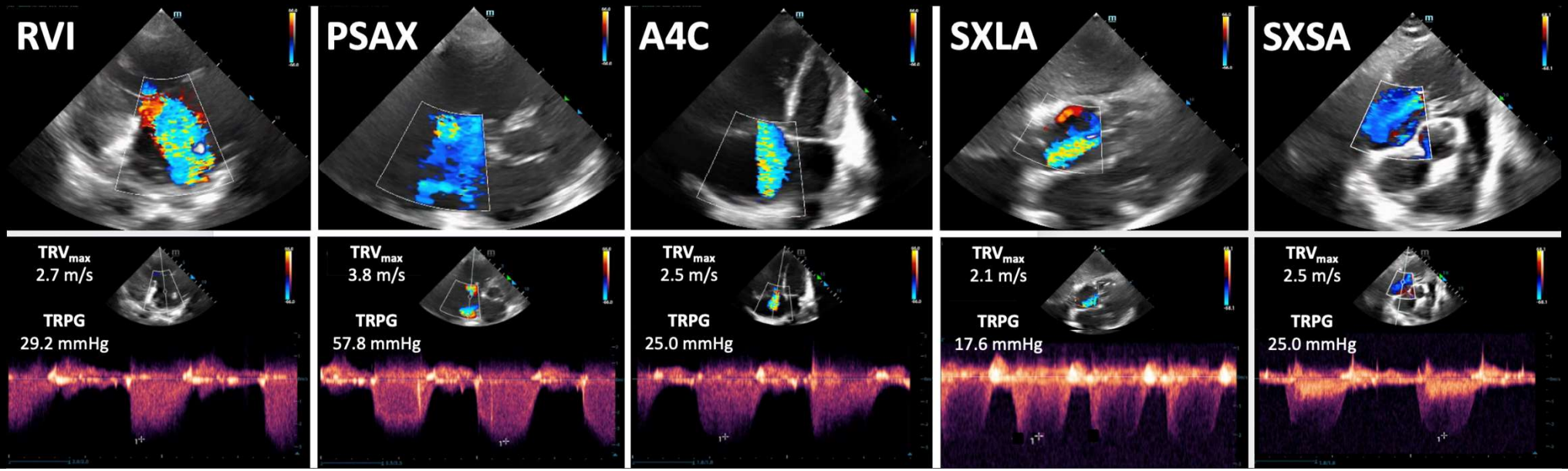
Tricuspid Regurgitation Pressure Gradient (ΔP_{RV-RA})

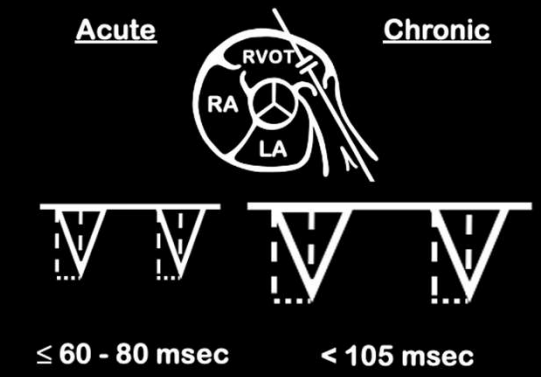


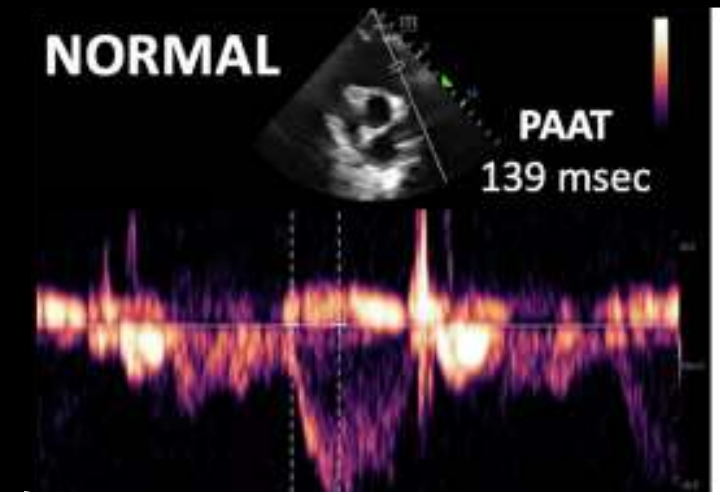
↑ values associated with mortality in PE/PH

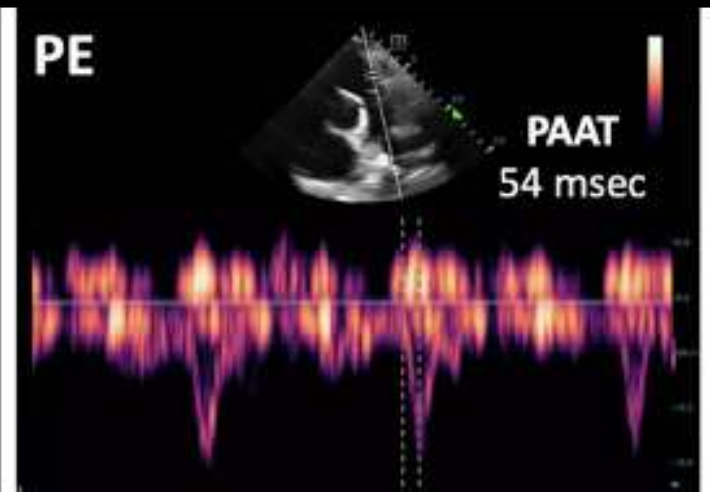
(or PASP > 60 mmHg)

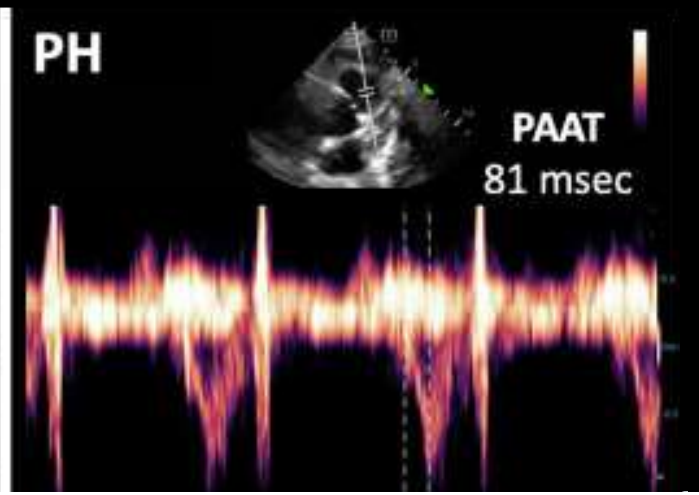


Pulmonary Artery Acceleration Time





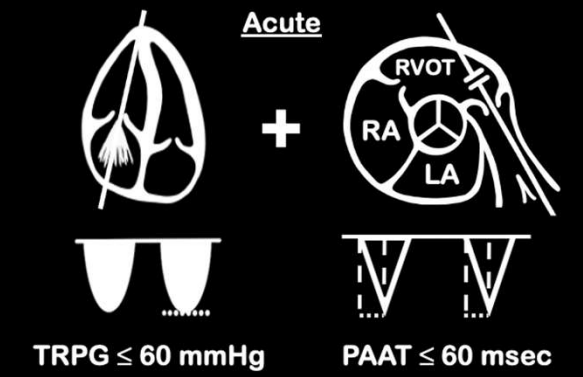


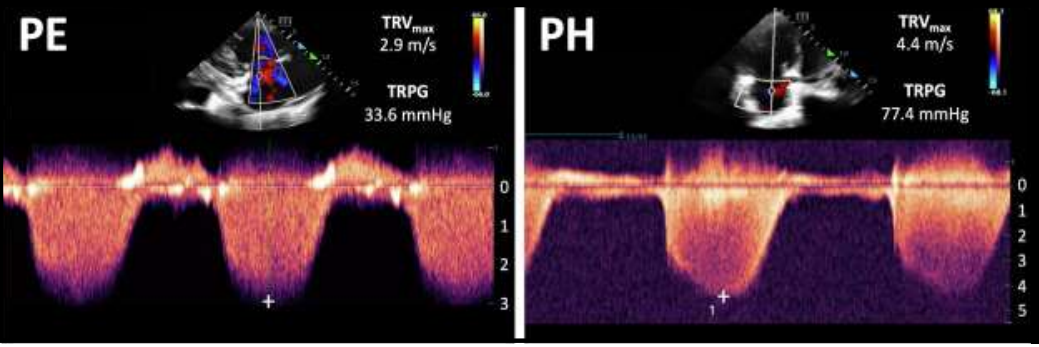


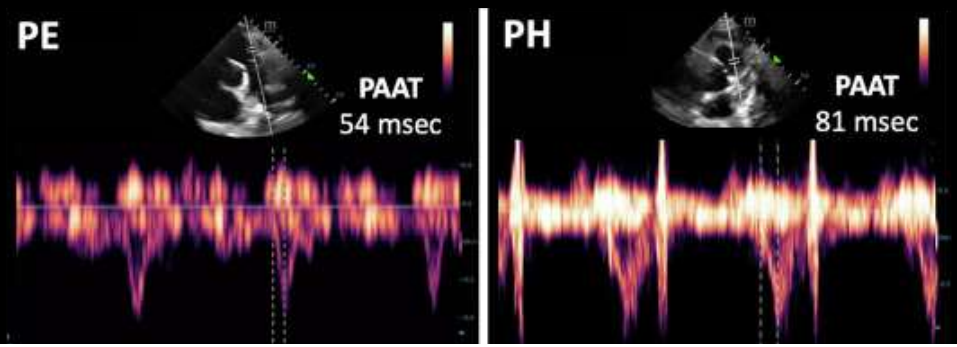
PE

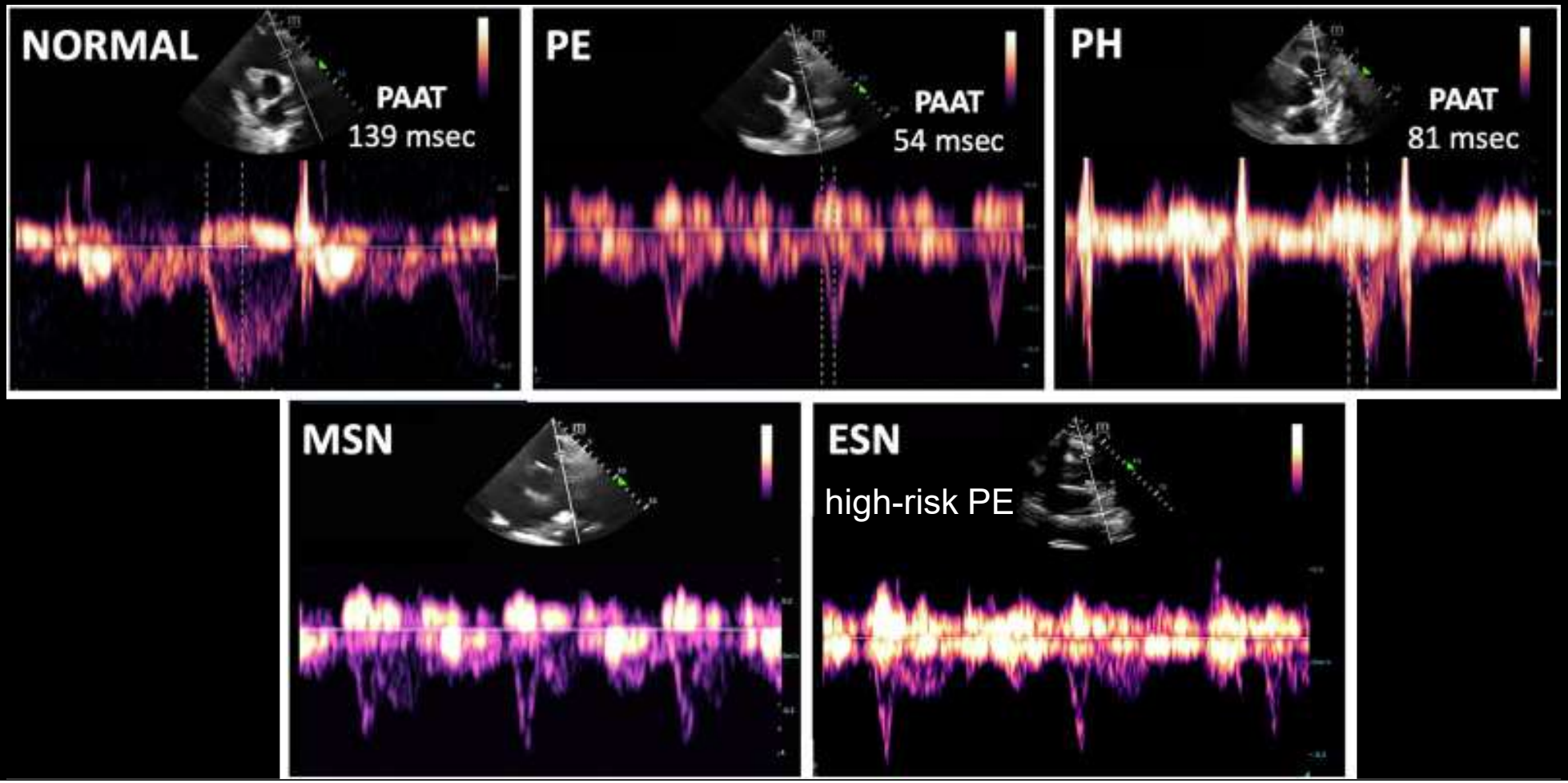
Sensitivity 13-51%
Specificity 69-98%

60 / 60 Sign








NORMAL
PAAT
139 msec
PE
PAAT
54 msec
PH
PAAT
81 msec
MSN
ESN
high-risk PE

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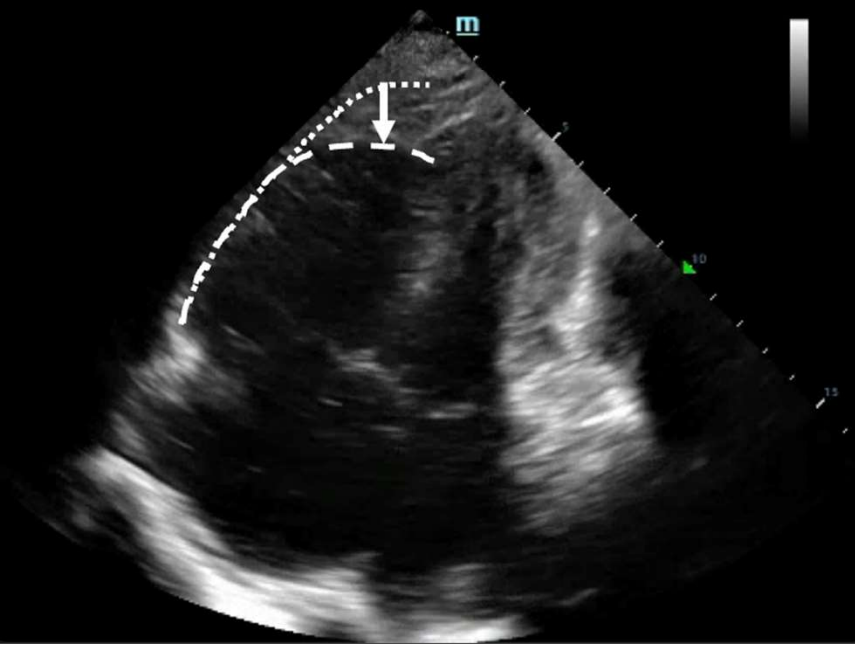
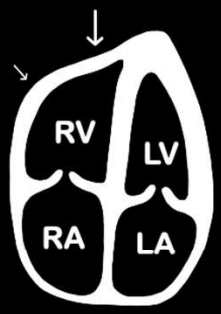
PE

Sensitivity 22%
Specificity 97%

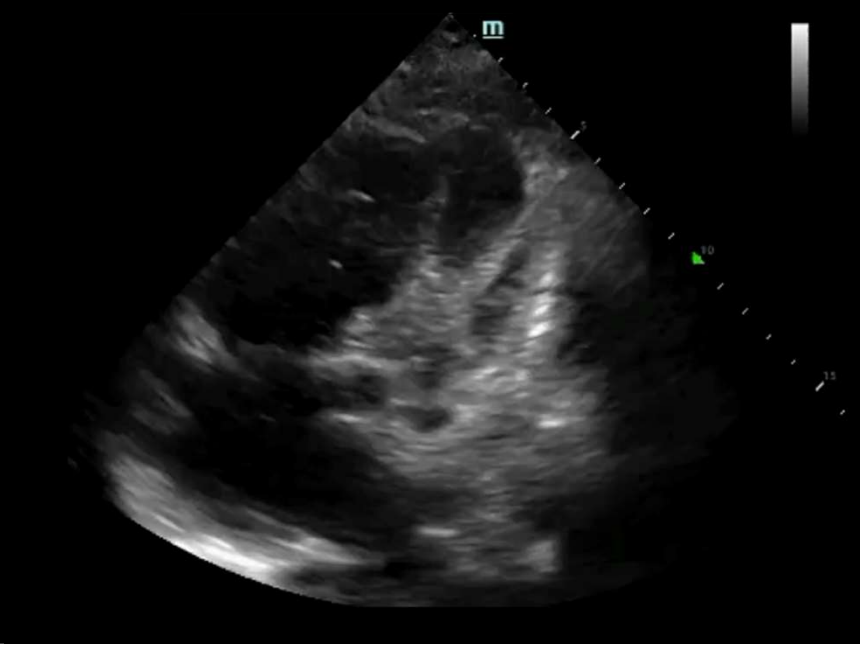


McConnell's Sign

Acute



↑ sensitivity with higher-risk PE's



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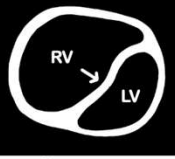
RIGHT VENTRICULAR DYSFUNCTION

Linda Qiu MD — *Stephen Alerhand MD*

Increased RV:LV Size Ratio

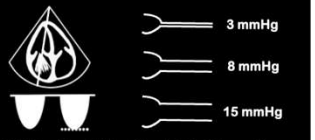
Abnormal Septal Motion



McConnell's Sign

Tricuspid Regurgitation

Elevated Pulmonary Artery Systolic Pressure



PASP = (4 x TRV_{max}^2) + RAP > 35 mmHg

Decreased TAPSE

Decreased S'

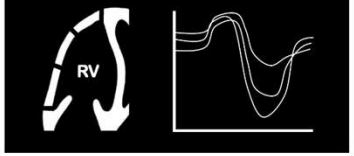
Pulmonary Artery Mid-Systolic Notching

60/60 Sign

(4 x TRV_{max}^2) < 60 mmHg

PAAT < 60 ms

Speckle Tracking: Decreased Free Wall Strain



ACUTE PULMONARY EMBOLISM VS CHRONIC PULMONARY HYPERTENSION

Linda Qiu MD — *Stephen Alerhand MD*

Right Heart Thrombus

Acute

Right Ventricular Free Wall Thickness

Acute — Chronic

≤ 5 mm — > 5 mm

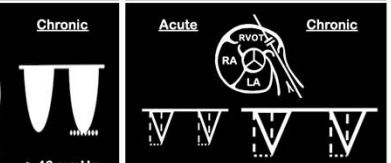
Tricuspid Regurgitation Pressure Gradient

Acute — Chronic

≤ 46 mmHg (≤ 3.4 m/sec) — 4 x TRV_{max}^2 — > 46 mmHg (> 3.4 m/sec)

Pulmonary Artery Acceleration Time

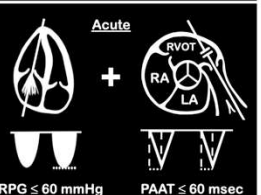
Acute — Chronic



≤ 60 - 80 msec — < 105 msec

60 / 60 Sign

Acute



TRPG ≤ 60 mmHg — PAAT ≤ 60 msec

Pulmonary Artery Early-Systolic Notching

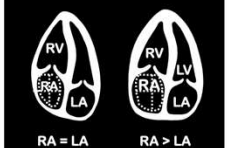
Proximally Located, Higher-Risk PE

McConnell's Sign

Acute

Right Atrial Enlargement

Acute — Chronic



RA = LA — RA > LA

Which of the following correctly describes how to estimate the TRPG and/or PASP?

A. A dilated, non-collapsible inferior vena cava corresponds to an estimated right atrial pressure of 15 mmHg.

B. A larger angle between emitted sound waves and regurgitant flow leads to an overestimated TRPG/PASP.

C. Pulsed wave Doppler is used to obtain the TRV_{max} from the TR Doppler waveform.

D. Tricuspid regurgitation can be obtained from the parasternal short-axis and apical 4-chamber views only.

Which echocardiographic finding is most specific to acute right ventricular dysfunction?

A. RV:LV size ratio > 1:1

B. Septal dyskinesia

C. Pulmonary artery acceleration time 85 msec

D. Pulmonary artery early-systolic notching

Which echocardiographic finding is most specific to chronic right ventricular dysfunction?

A. Right ventricular free wall thickness 3.7 mm

B. S' 8 cm/s

C. TAPSE 15 mm

D. TRPG 62 mmHg

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