Acute respiratory failure:

What I want to know from echo

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Dept Medicine, University of Sydney

YouTube Echo at Nepean

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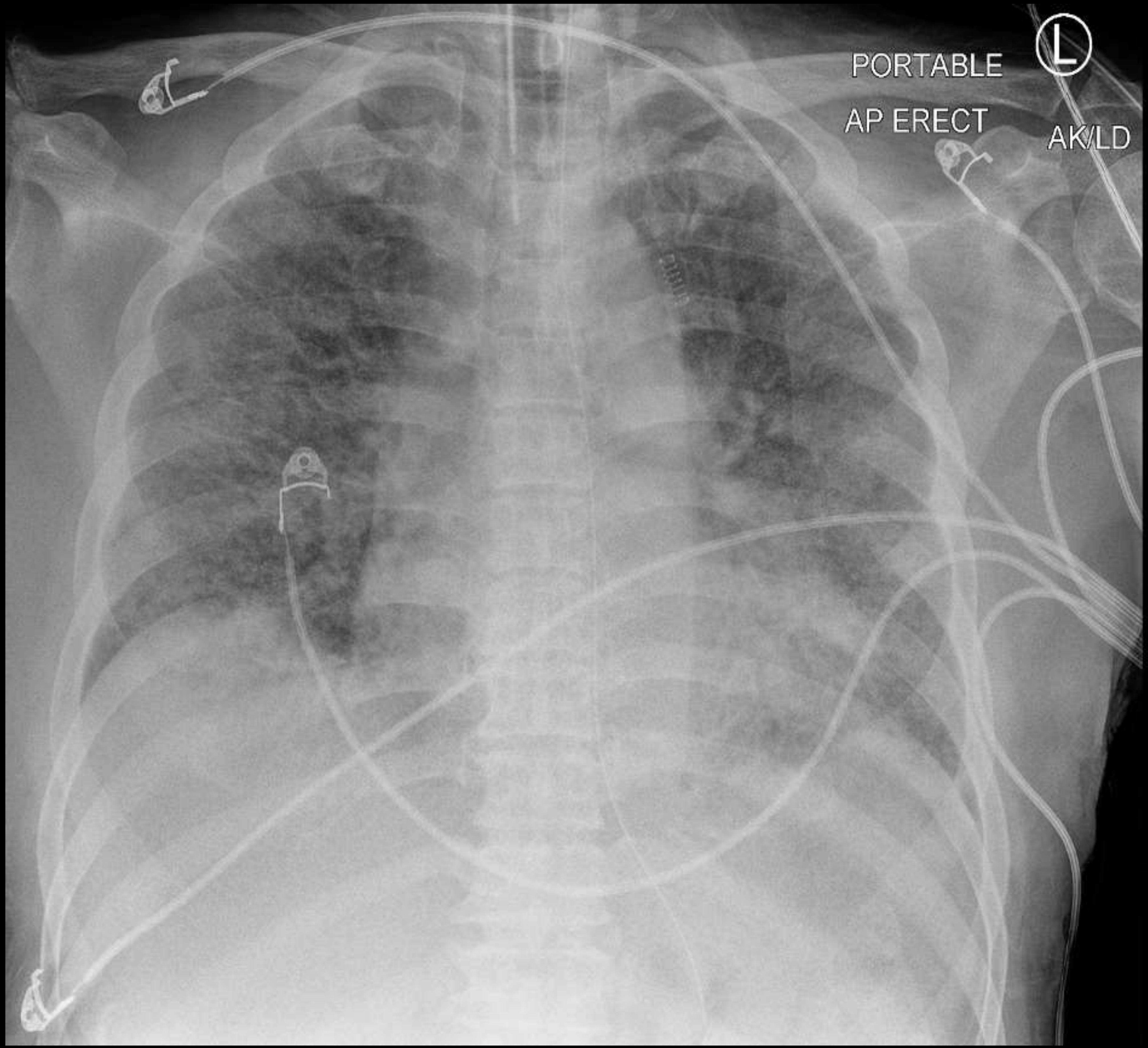
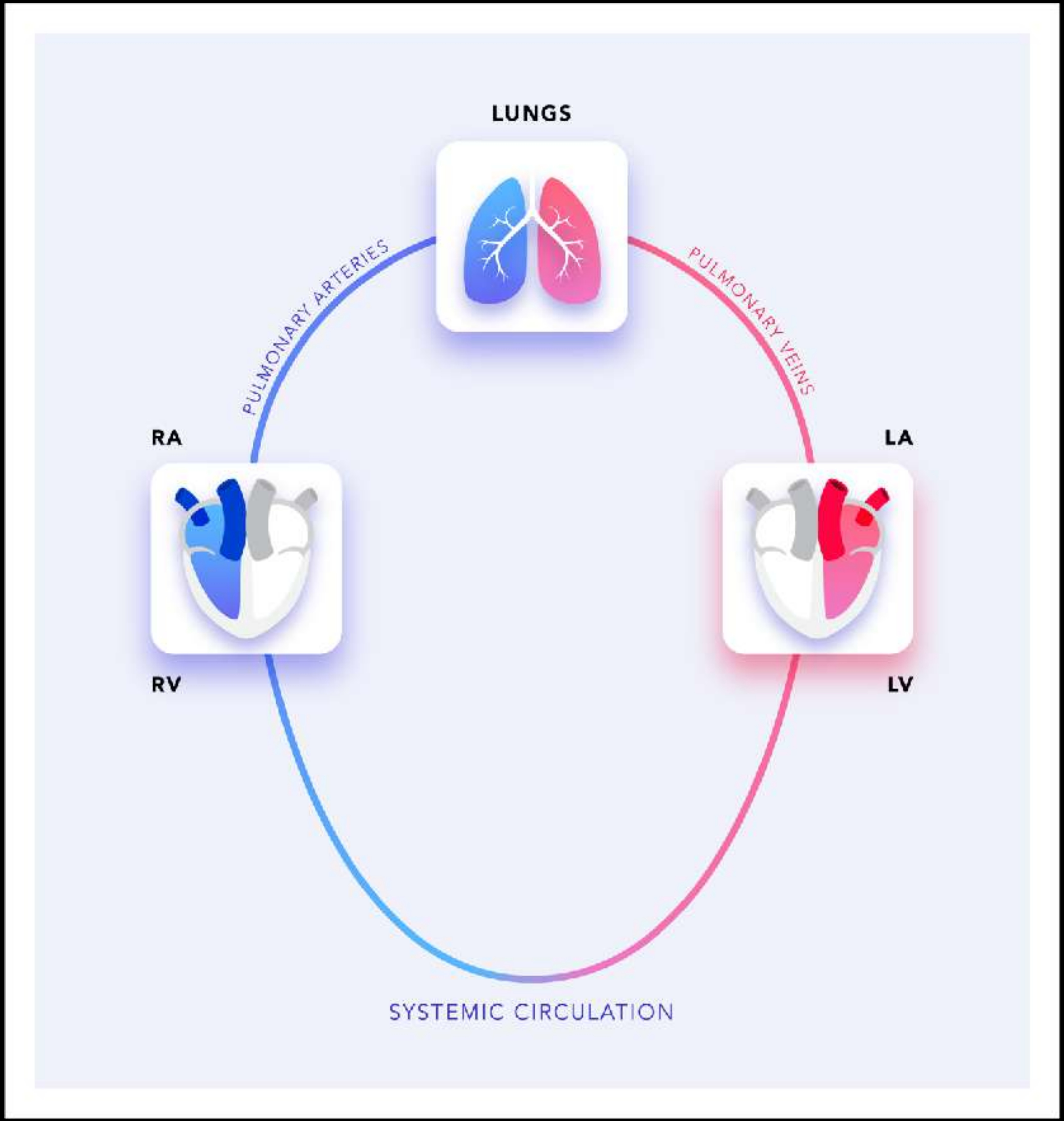
18th March 2025 (15mins 14:20-14:35)

No relevant disclosures





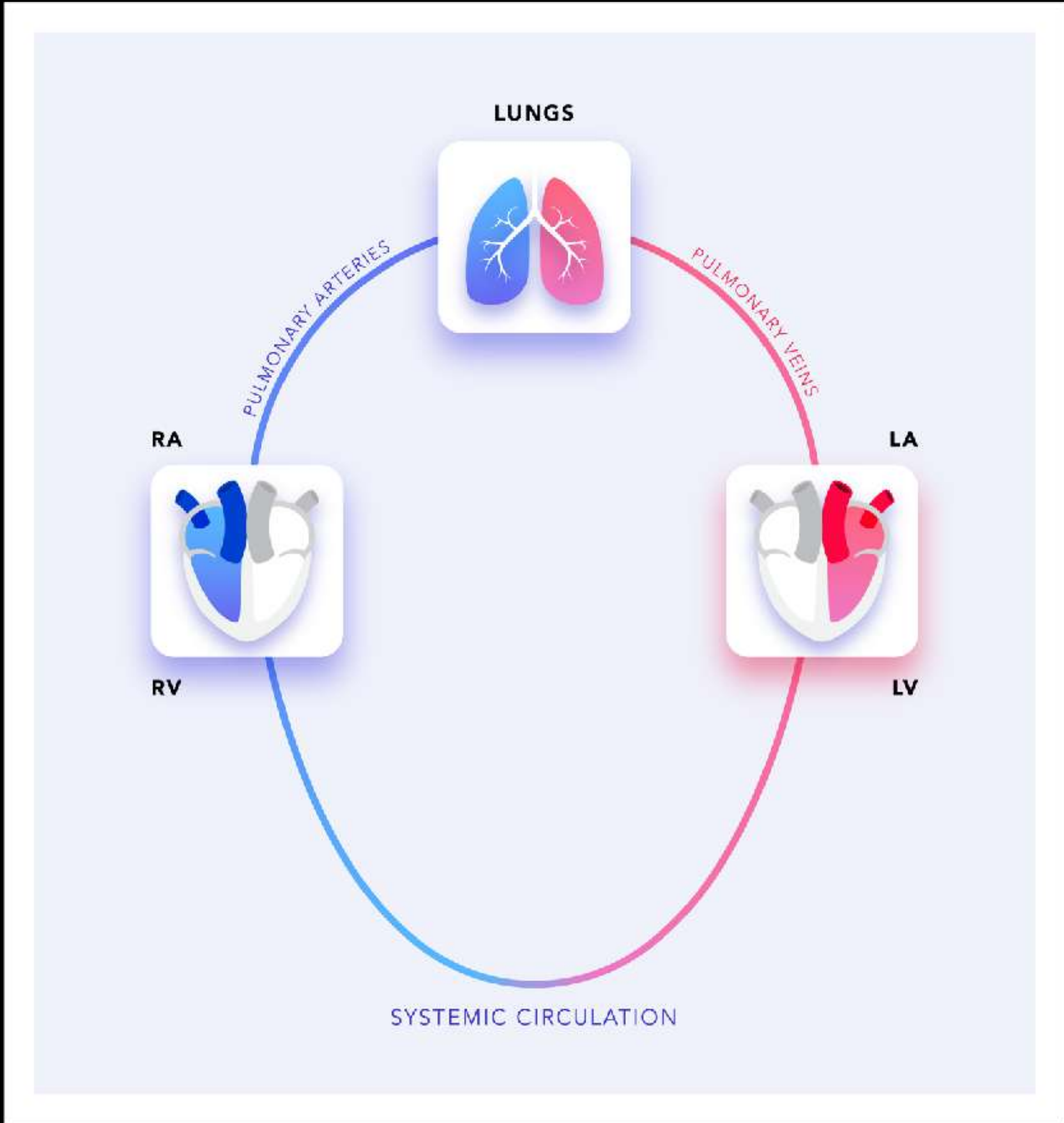
ECHO AUSTRALIA

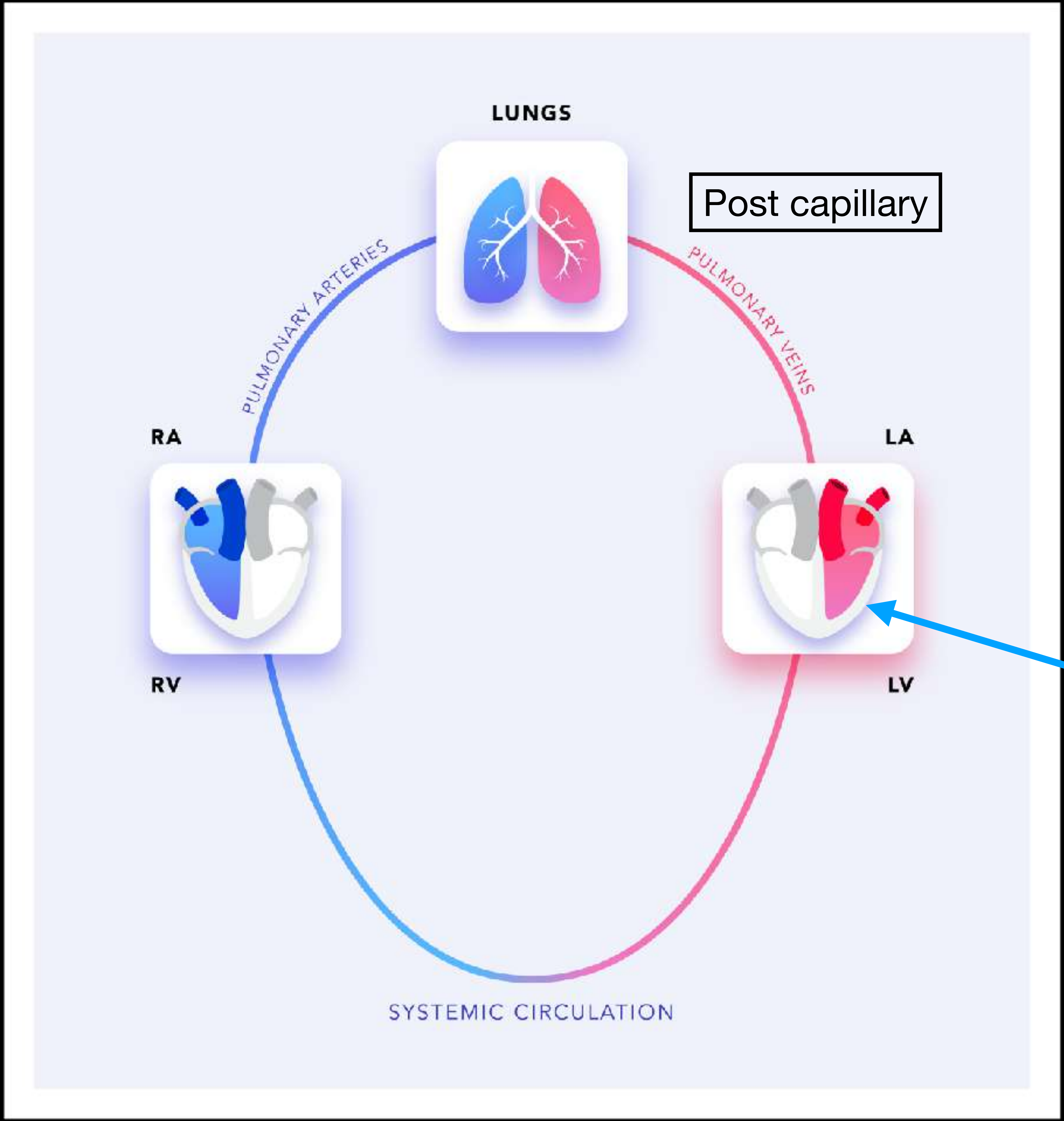
Overview

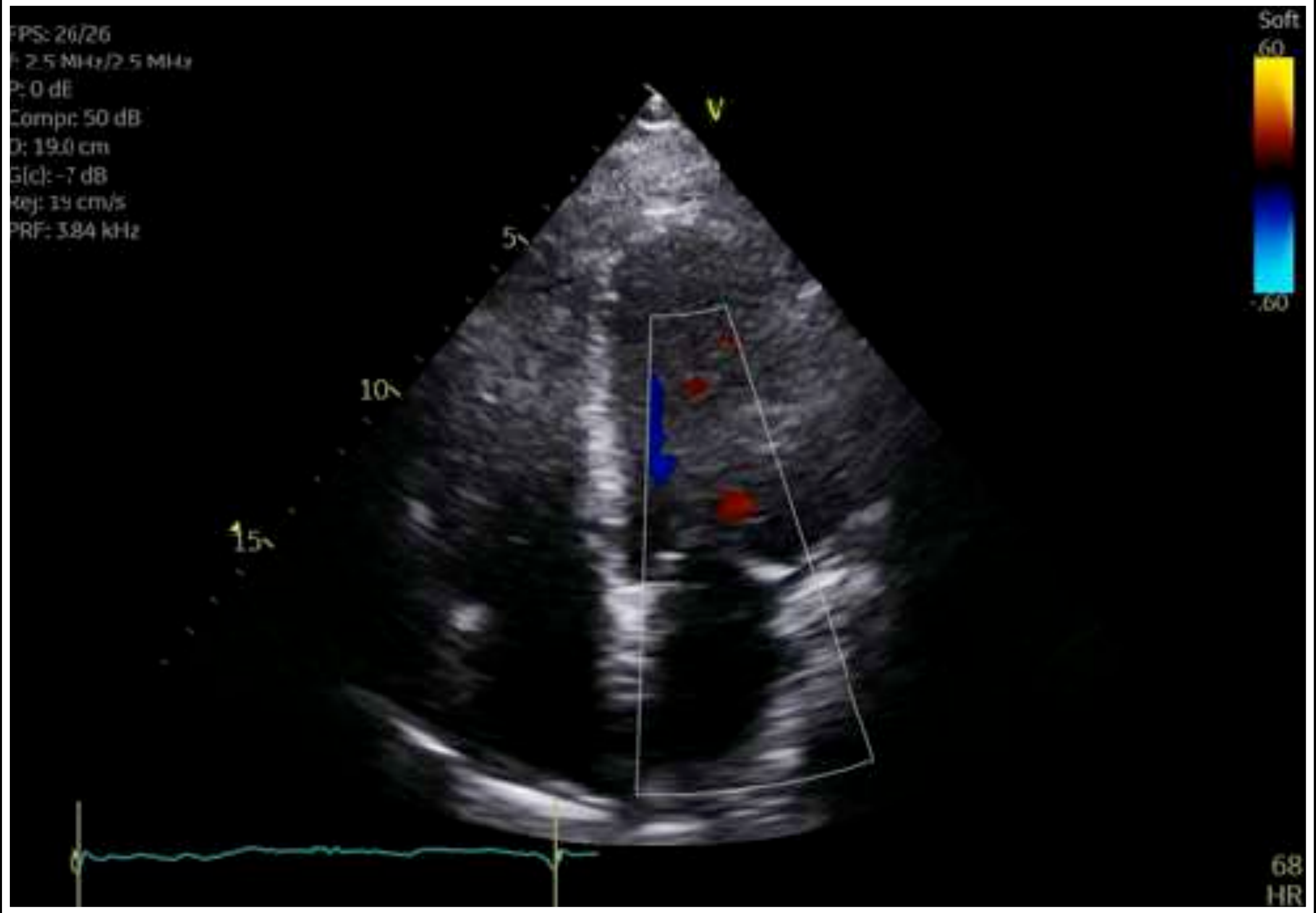
Echo 'phenotypes'

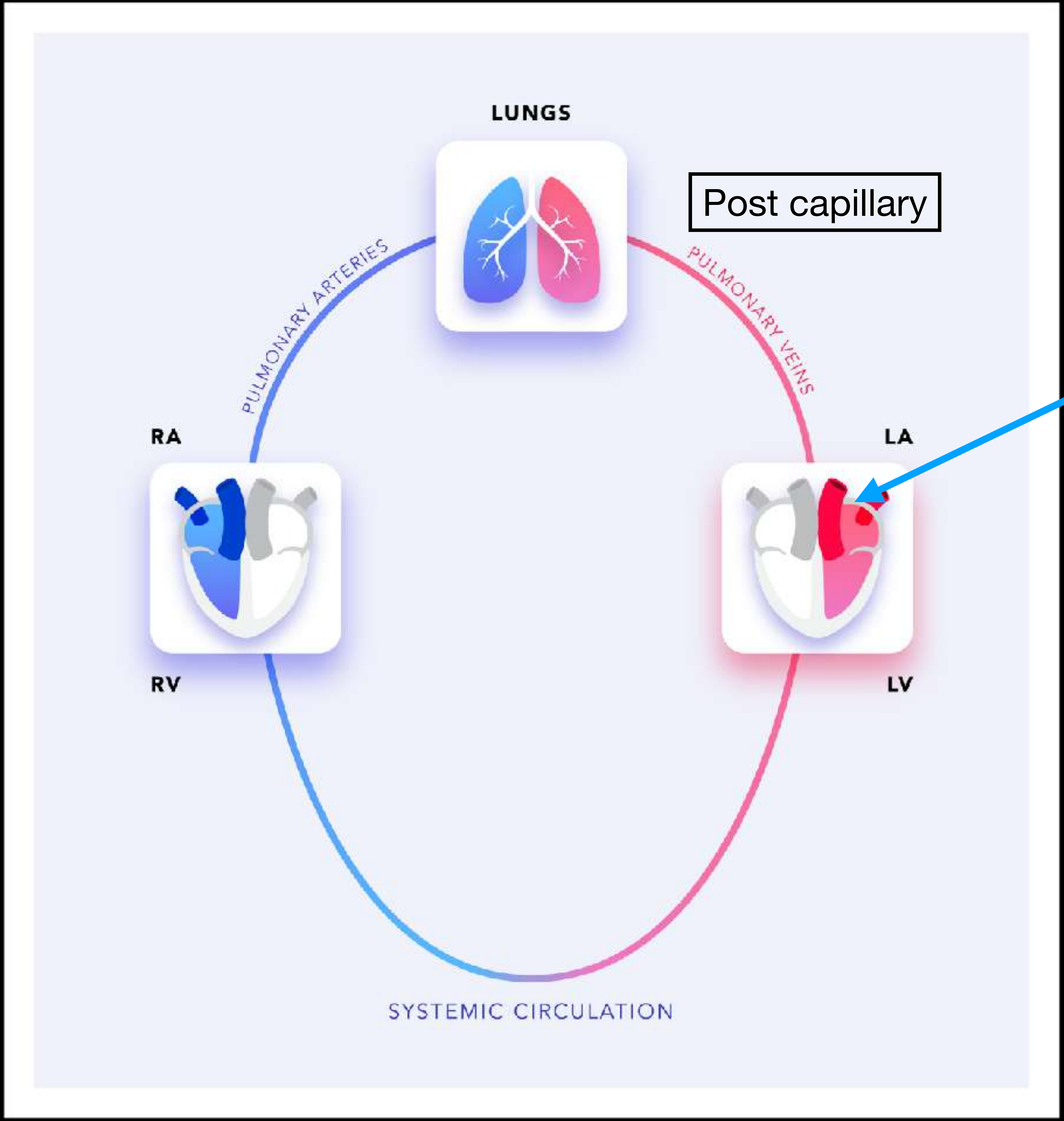
- LV systolic function (& valves)
- LA pressure
- Extravascular lung water
- RV afterload
- RV systolic function

=> possible management choices




LUNGS
Post capillary
PULMONARY ARTERIES
PULMONARY VEINS
RA
LA
RV
LV
SYSTEMIC CIRCULATION

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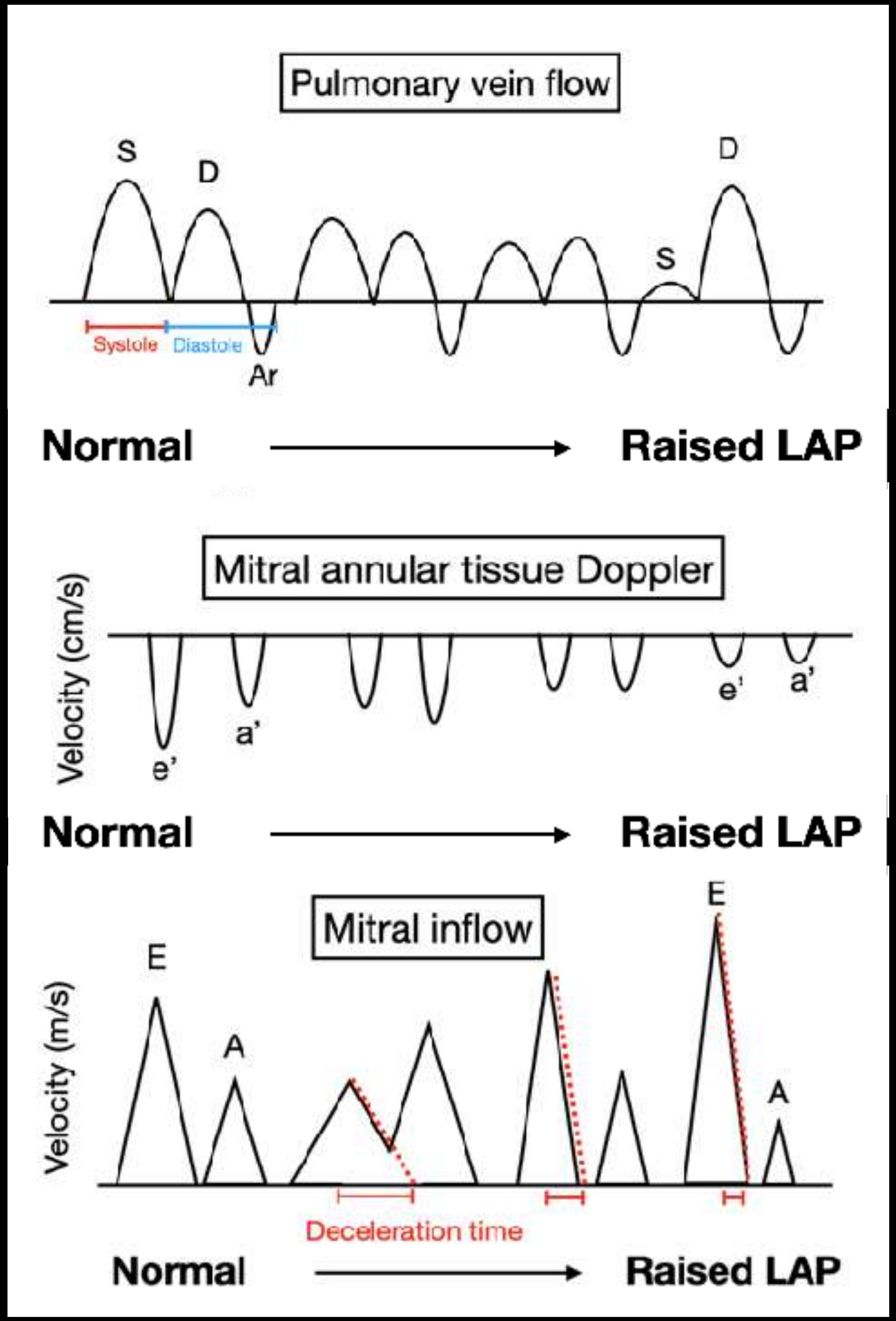
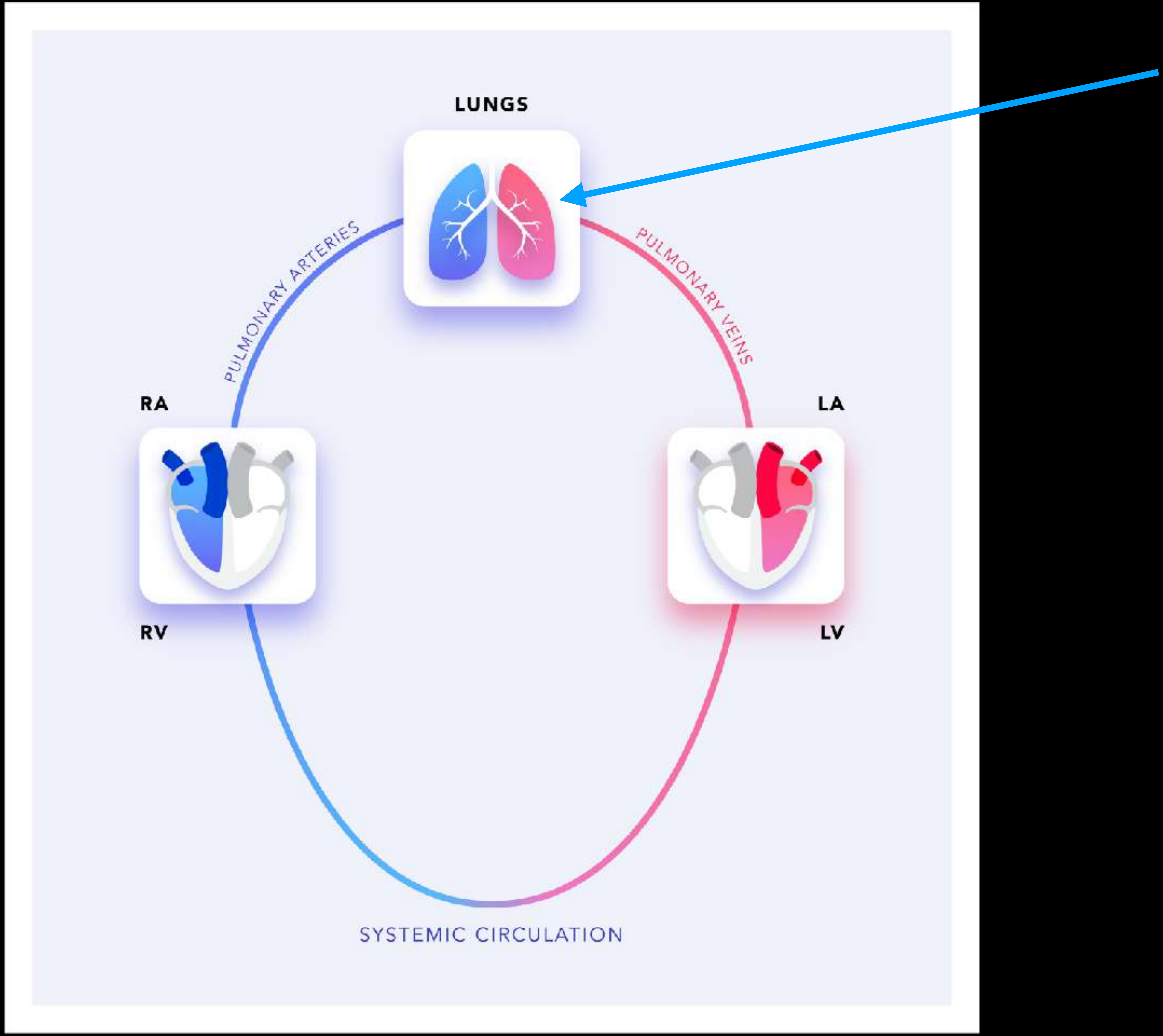

Pulmonary vein flow
S
D
S
D
Systole
Diastole
Ar
Normal
Raised LAP
Mitral annular tissue Doppler
Velocity (cm/s)
e'
a'
e'
a'
Normal
Raised LAP
Mitral inflow
Velocity (m/s)
E
A
E
A
Deceleration time
Normal
Raised LAP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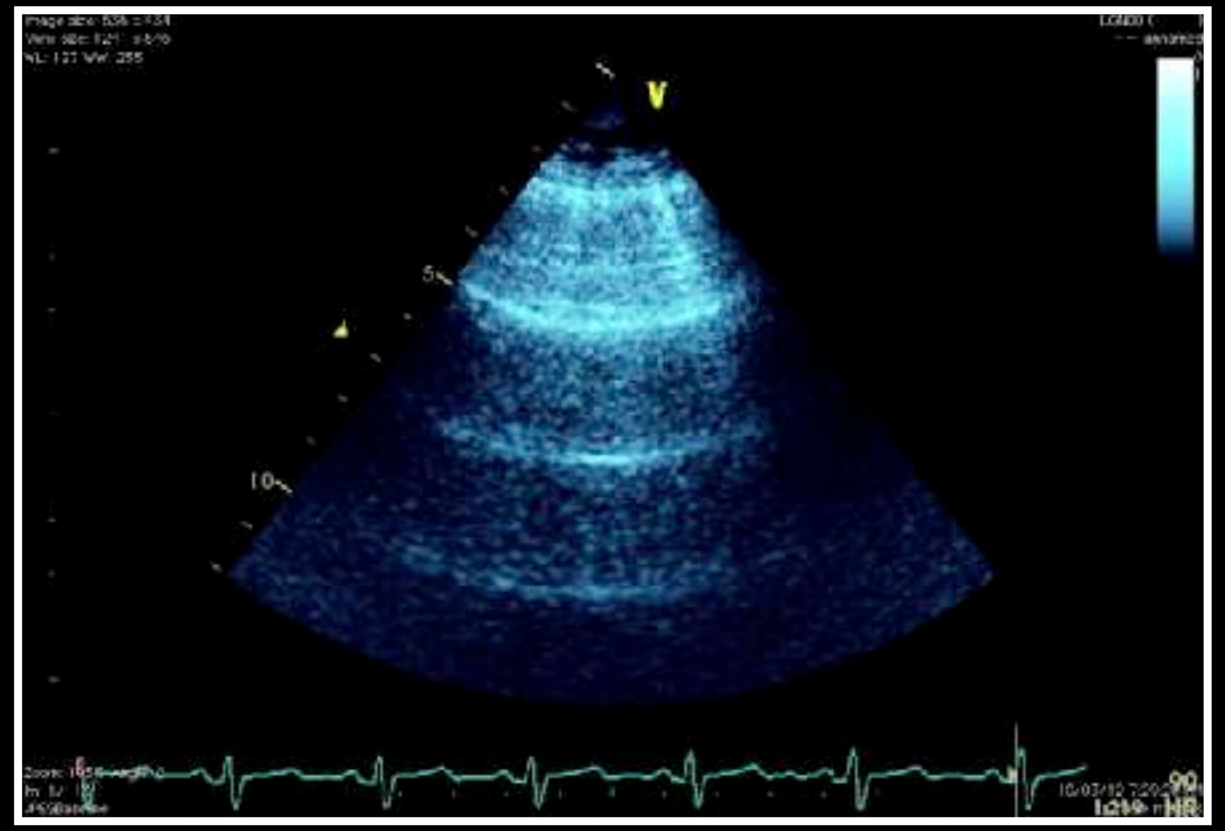
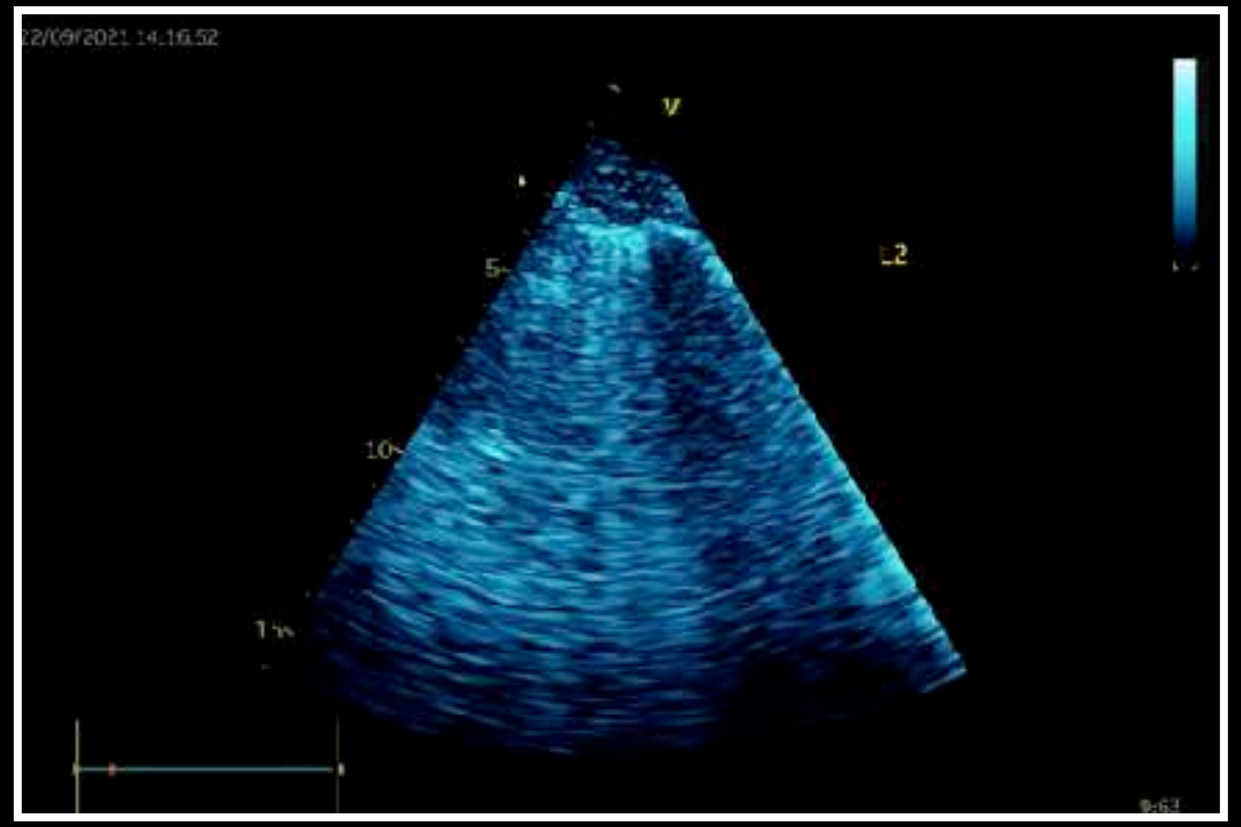
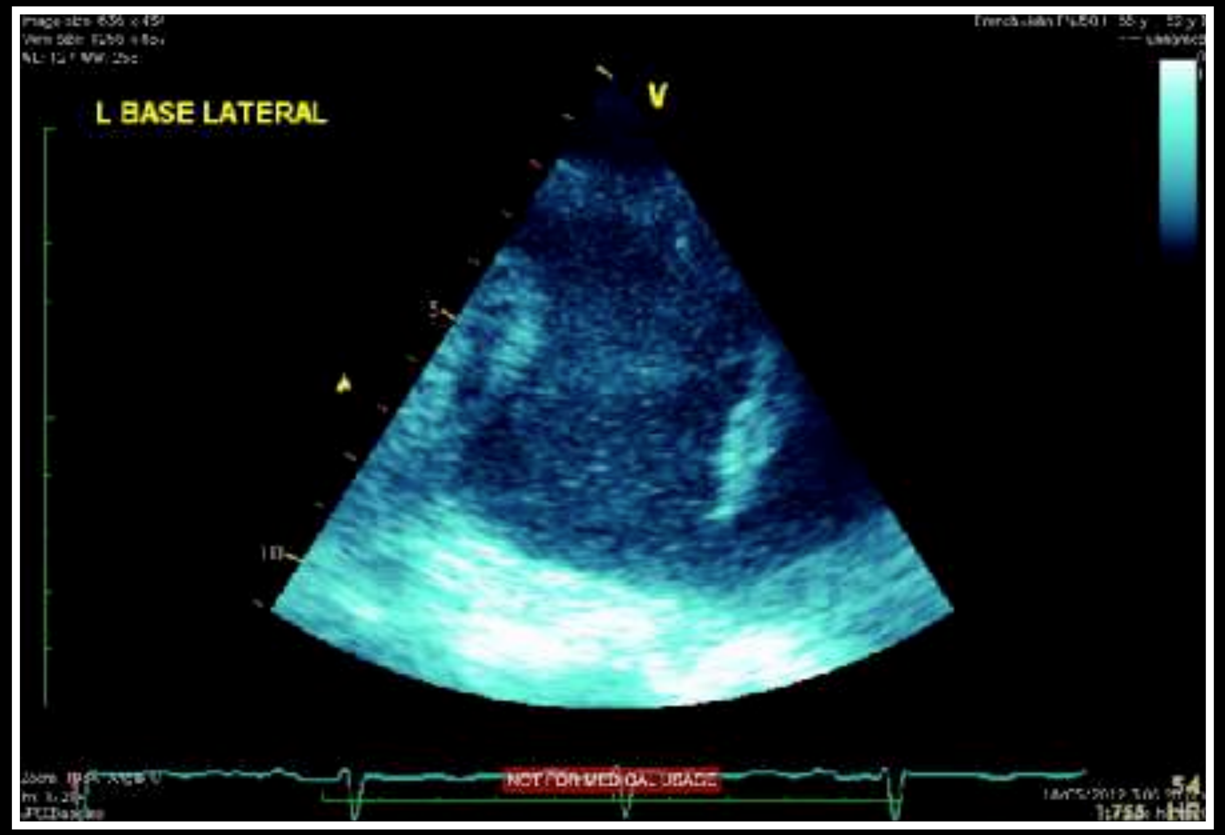
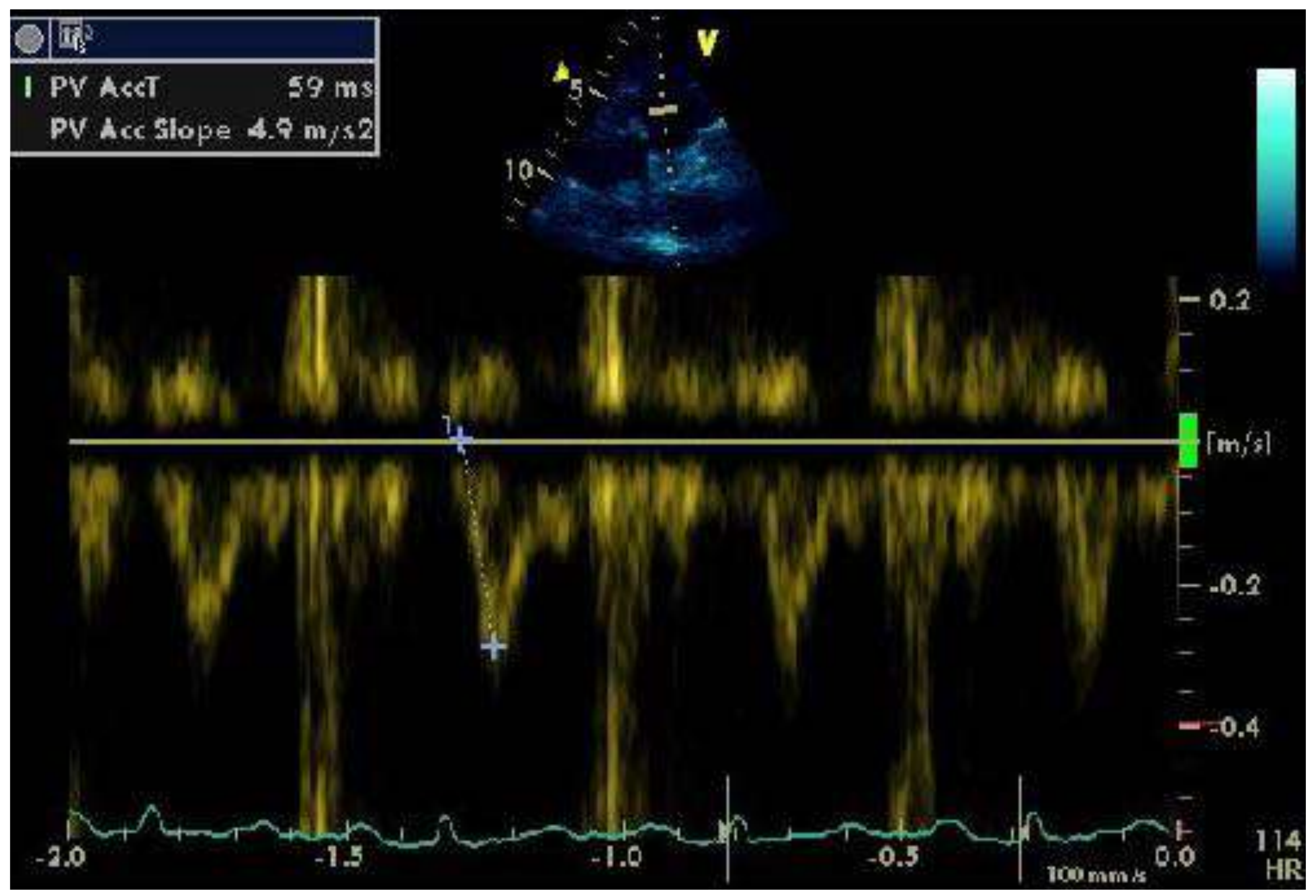
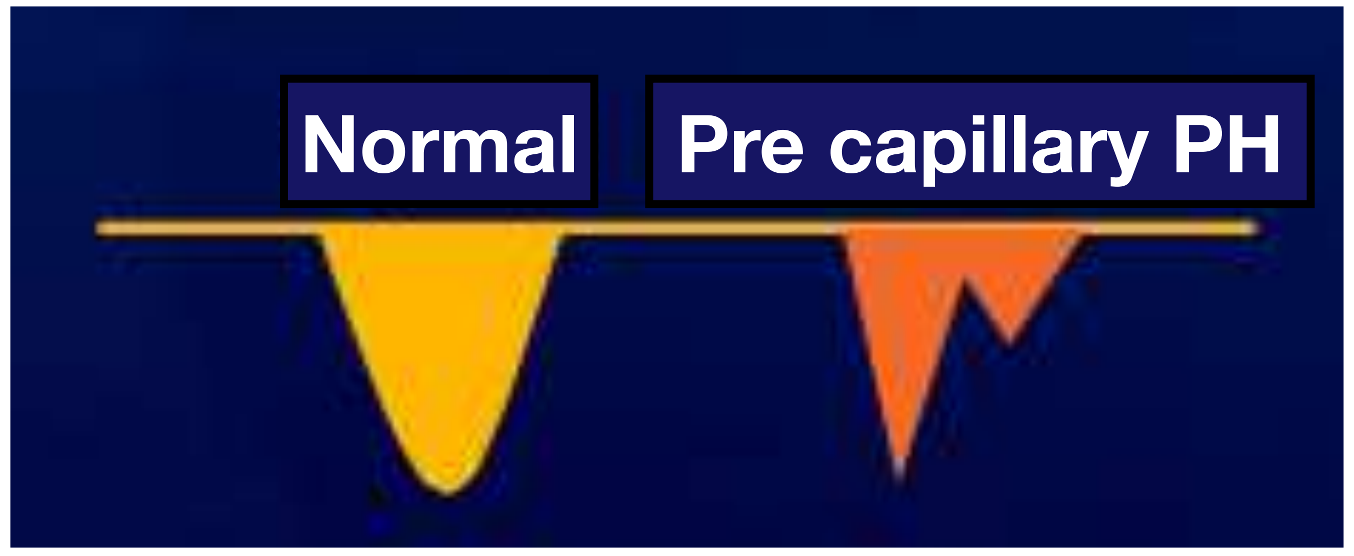
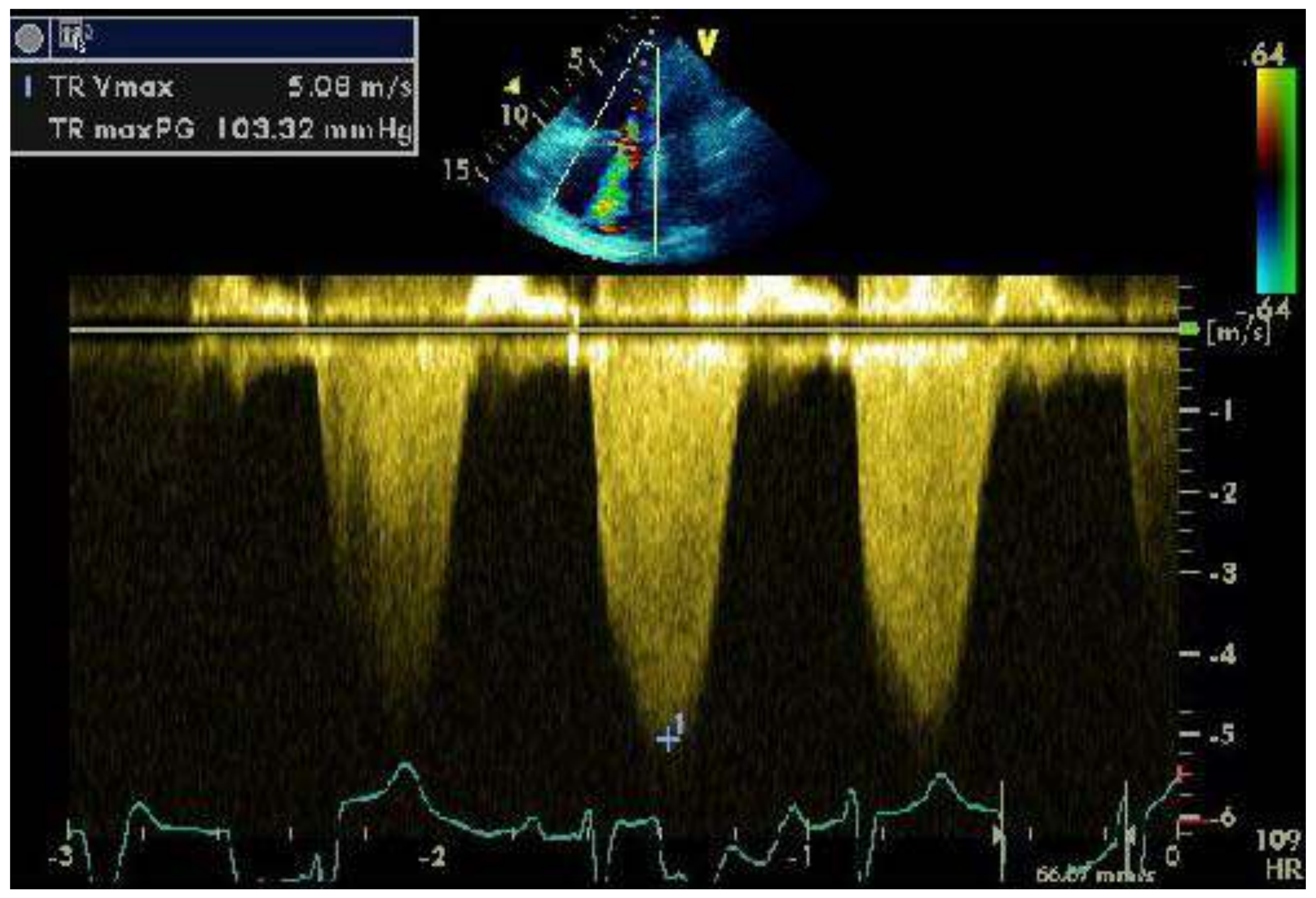


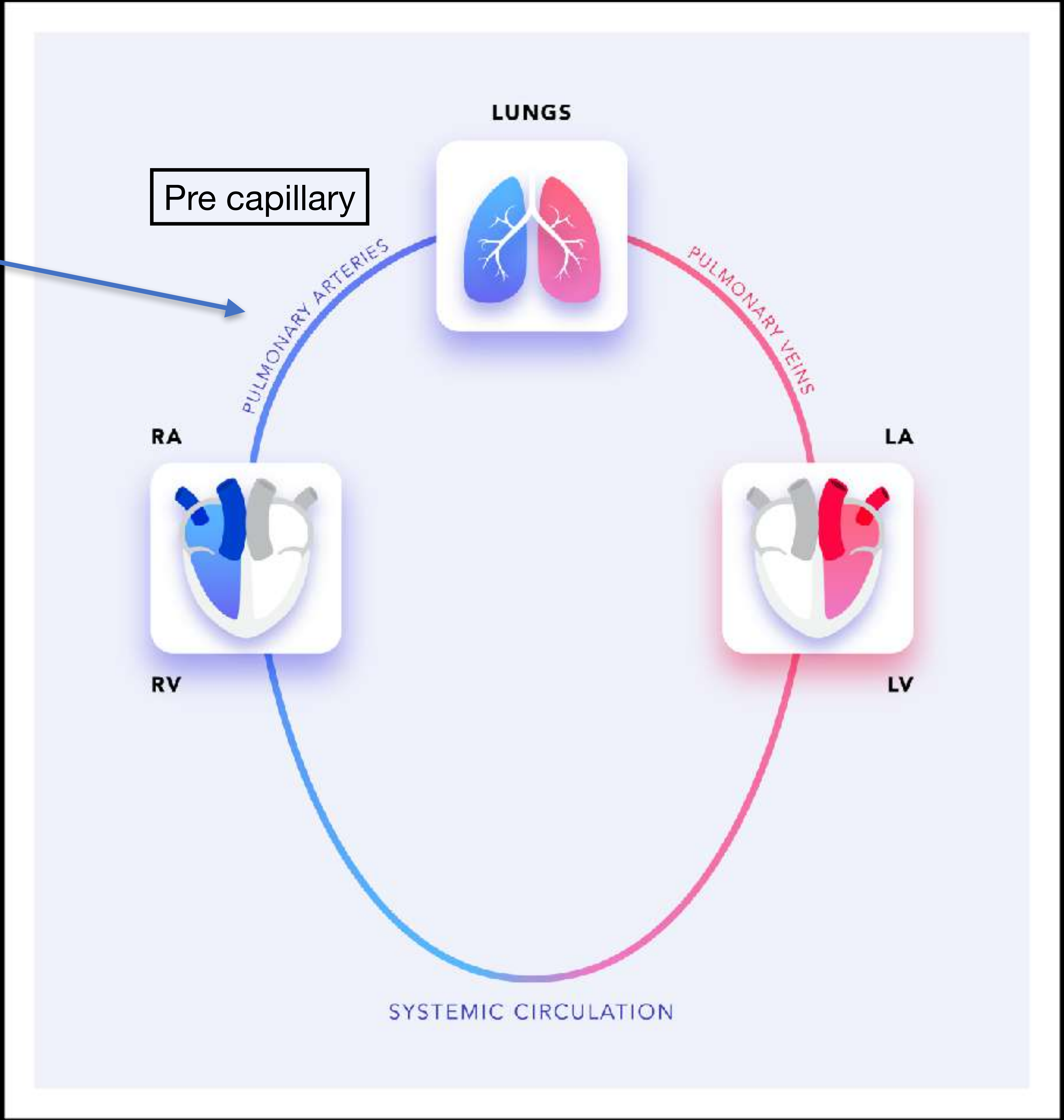



L BASE LATERAL


PV AccT 59 ms
PV Acc Slope 4.9 m/s2


Normal
Pre capillary PH


TR Vmax 5.08 m/s
TR maxPG 103.32 mmHg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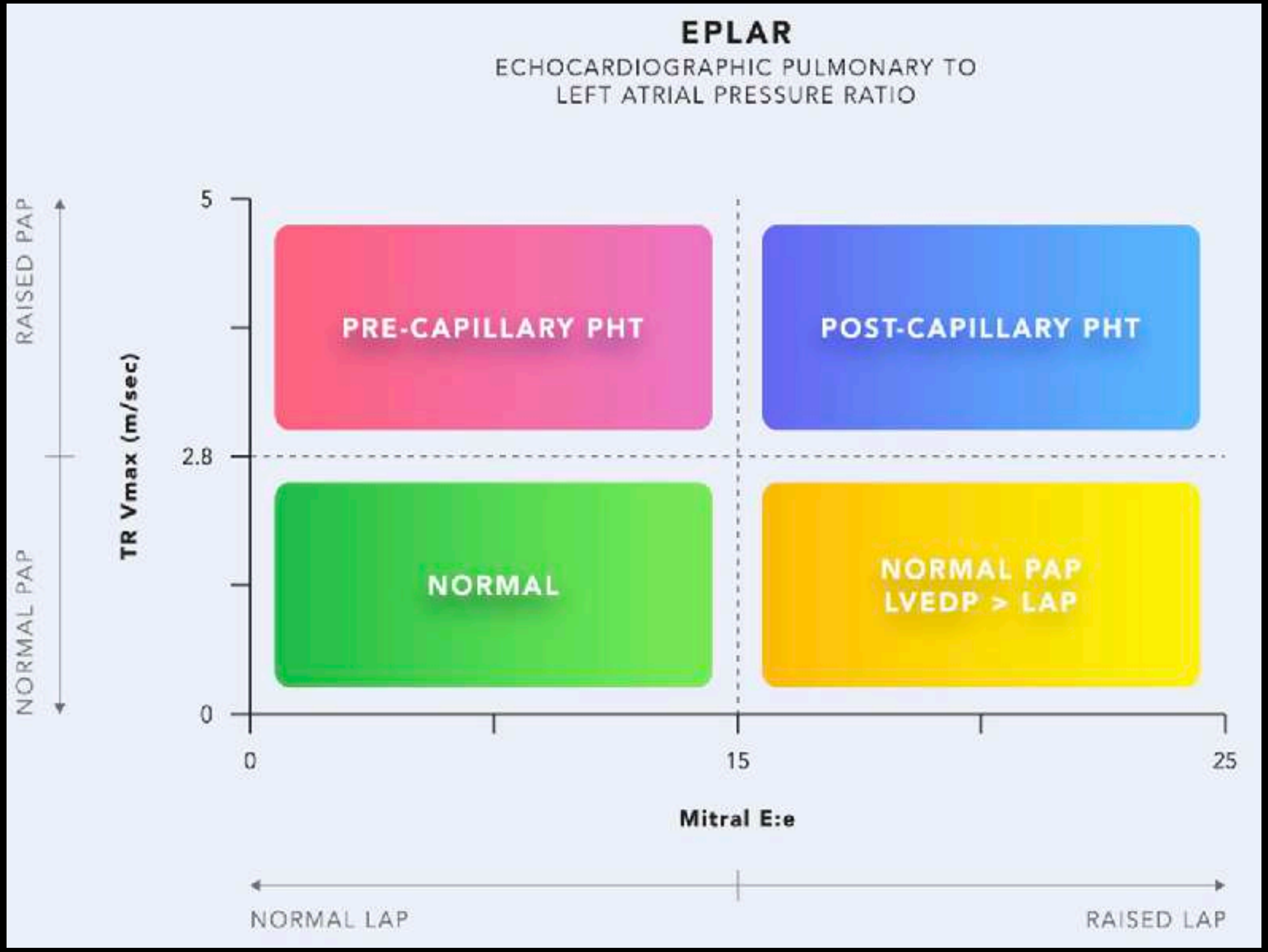
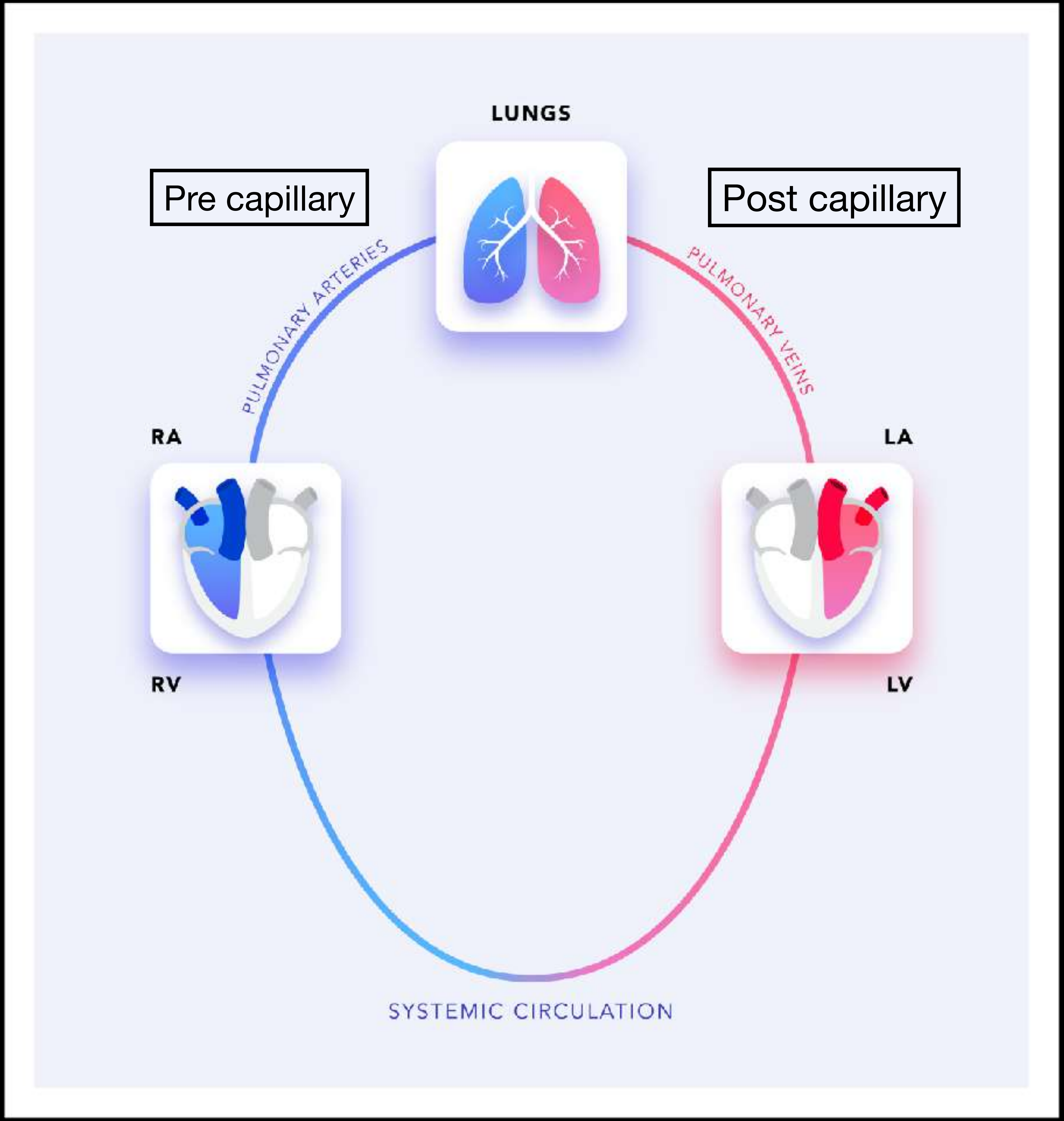


EPLAR
ECHOCARDIOGRAPHIC PULMONARY TO LEFT ATRIAL PRESSURE RATIO
RAISED PAP
NORMAL PAP
TR Vmax (m/sec)
5
2.8
0
PRE-CAPILLARY PHT
POST-CAPILLARY PHT
NORMAL
NORMAL PAP
LVEDP > LAP
0
15
25
Mitral E:e
NORMAL LAP
RAISED LAP



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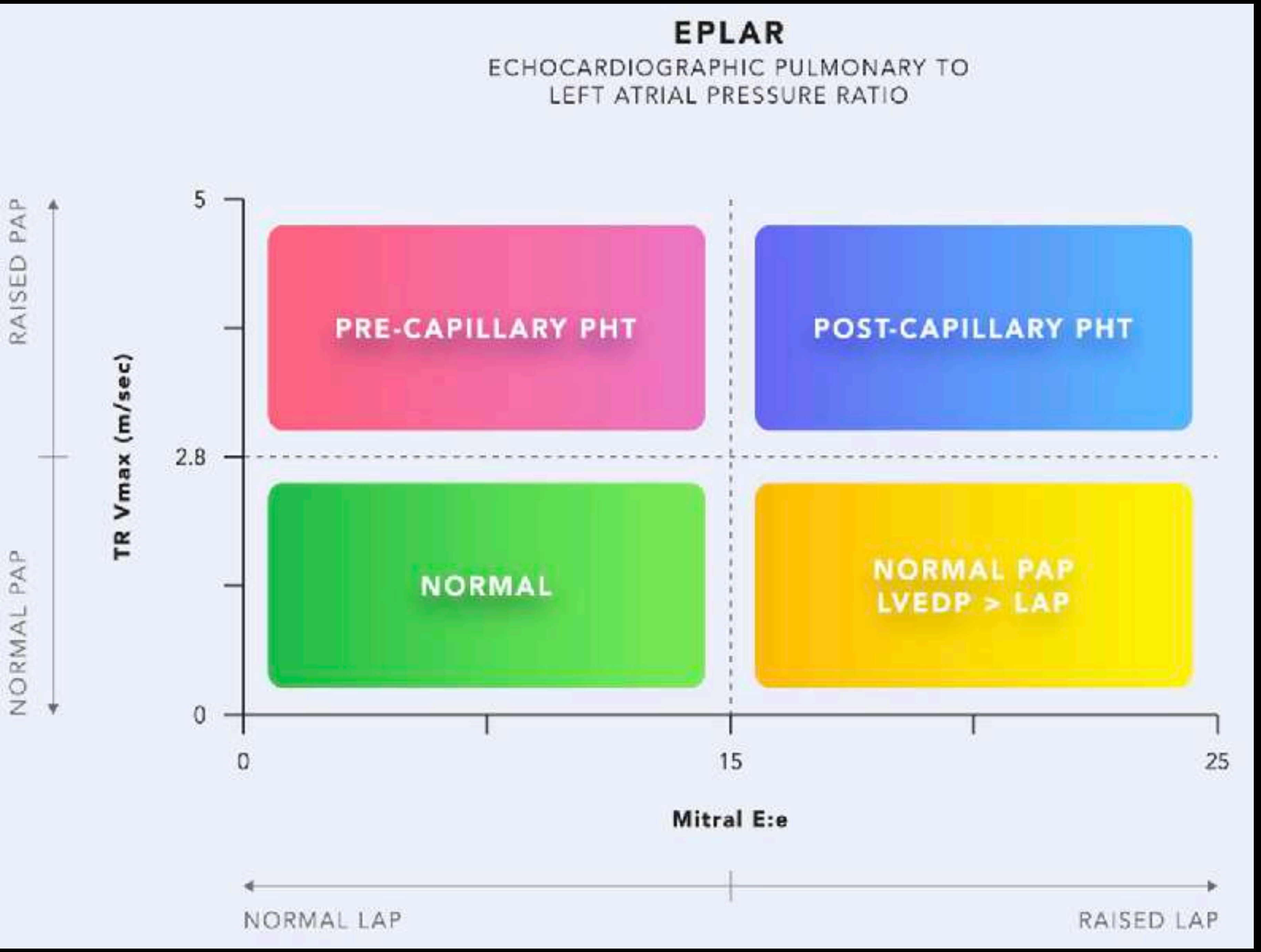
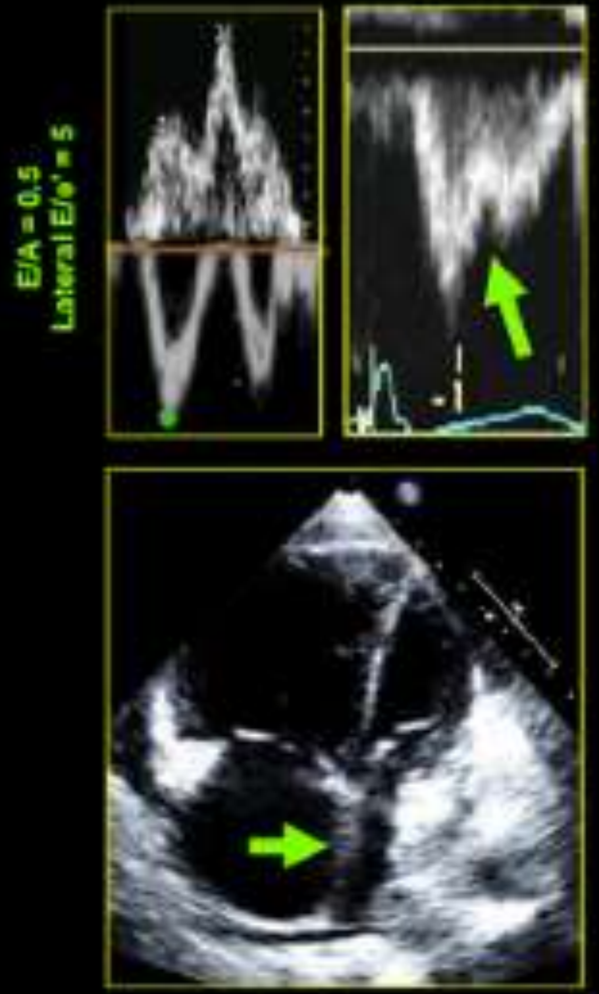
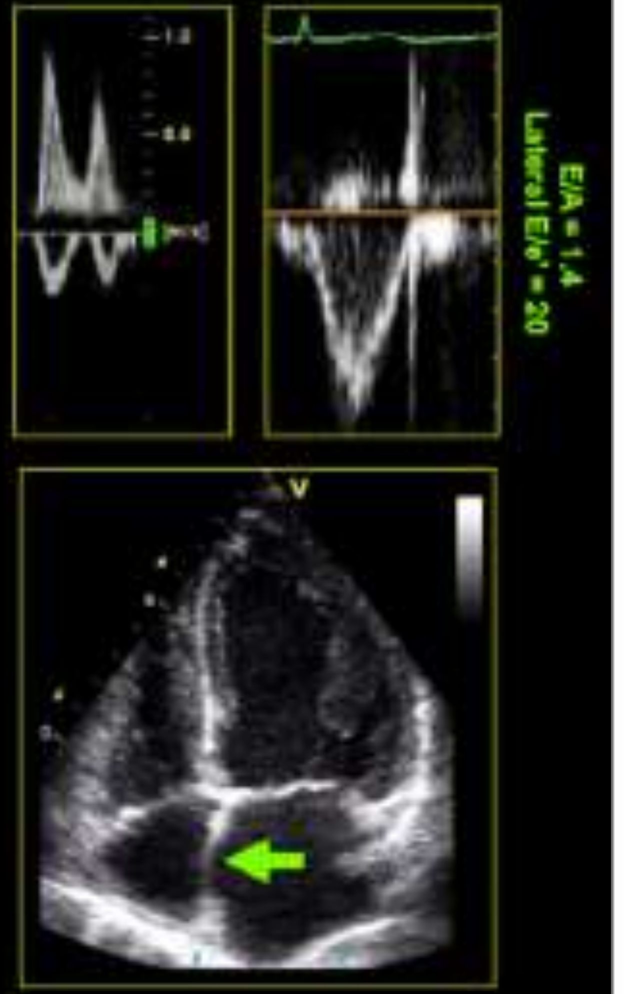


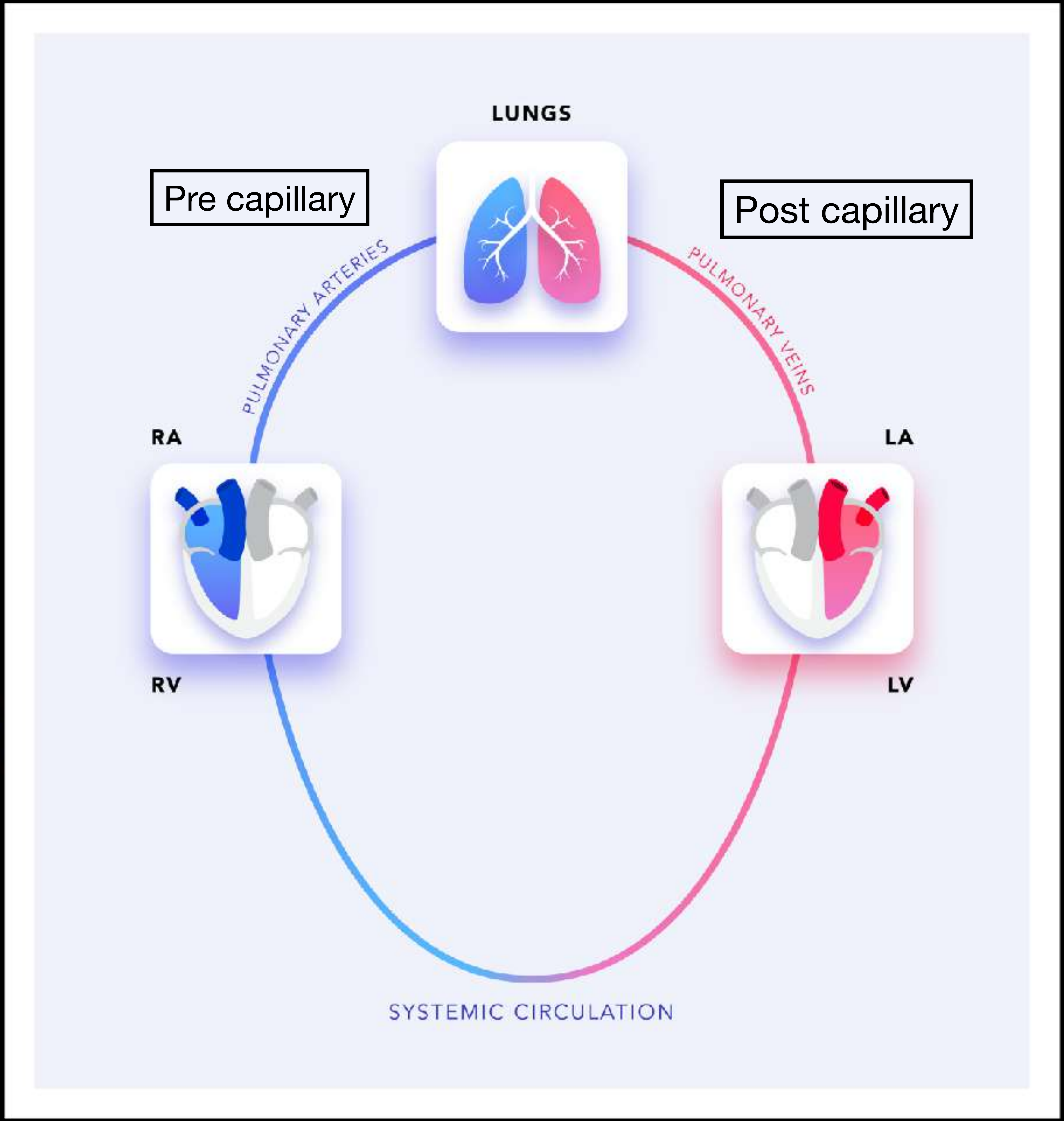


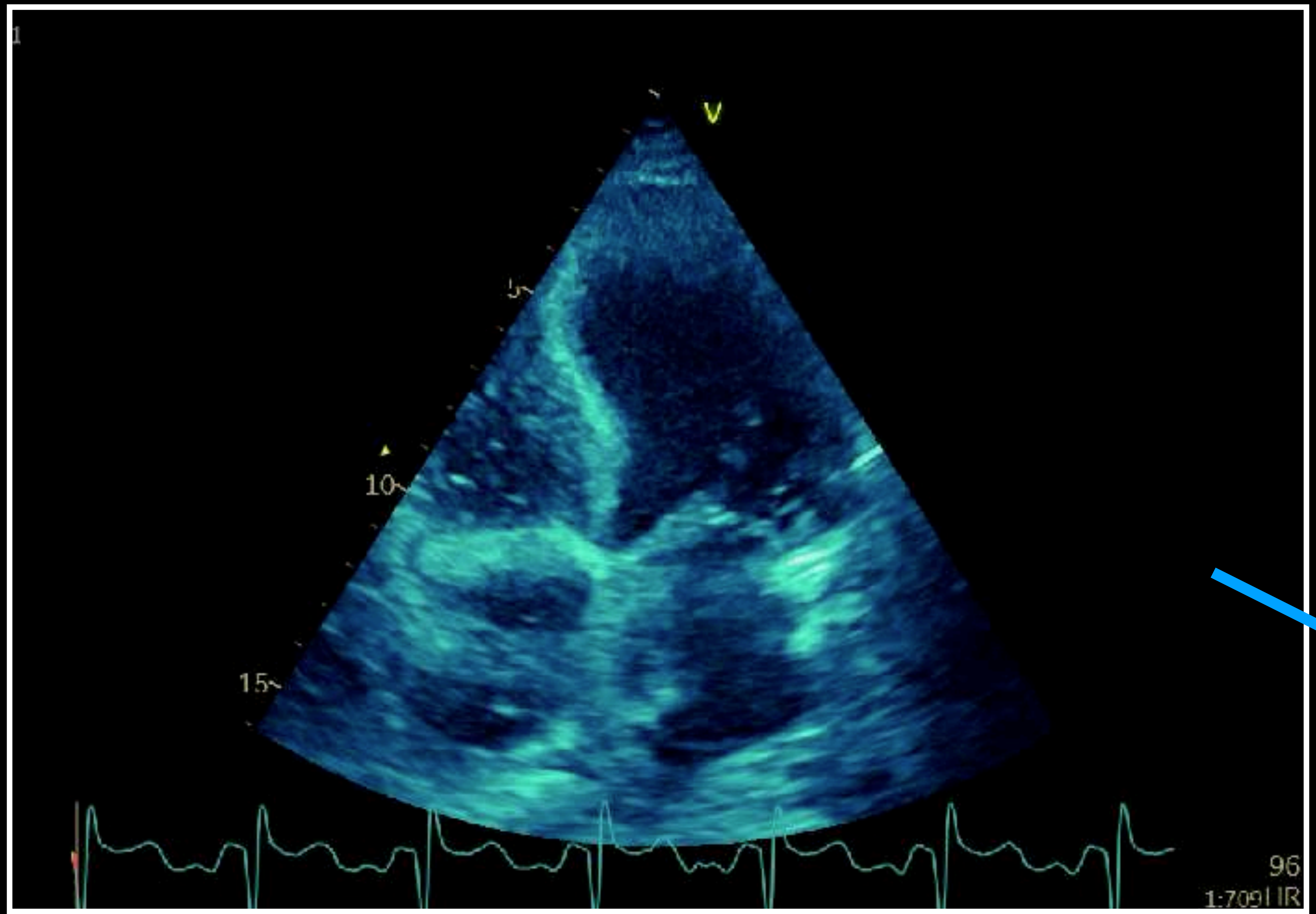
Parameter	PAH	PVH
RV size	Enlarged	May be enlarged
LA size	Small	Large
RA/LA size ratio	Increased	Normal (LA > RA size)
Interatrial septum	Bows from right to left	Bows from left to right
RVOT notching	Common	Rare
E/A ratio	<< 1	> 1
Lateral e'	Normal	Decreased
Lateral E/e'	< 8	> 10
Aortic pressure	Normal/Low	Normal/High
PCWP	≤ 15 mmHg	> 15 mmHg
PADP-PCWP	> 7 mmHg	< 5 mmHg



Pre capillary

Post capillary





Prevalence and prognosis of shunting across patent foramen ovale during acute respiratory distress syndrome*

Armand Mekontso Dessap, MD, PhD; Florence Boissier, MD; Rusel Leon, MD; Serge Carreira, MD; Ferran Roche Campo, MD; François Lemaire, MD; Laurent Brochard, MD

Crit Care Med 2010 Vol. 38, No. 9

Objective: Right-to-left shunting across a patent foramen ovale may occur in acute respiratory distress syndrome as a result of pulmonary hypertension and positive-pressure mechanical ventilation. The shunt may worsen the hypoxemia. The objective of our study was to determine the prevalence, clinical implications, and prognosis of patent foramen ovale shunting during acute respiratory distress syndrome.

Design: Prospective study.

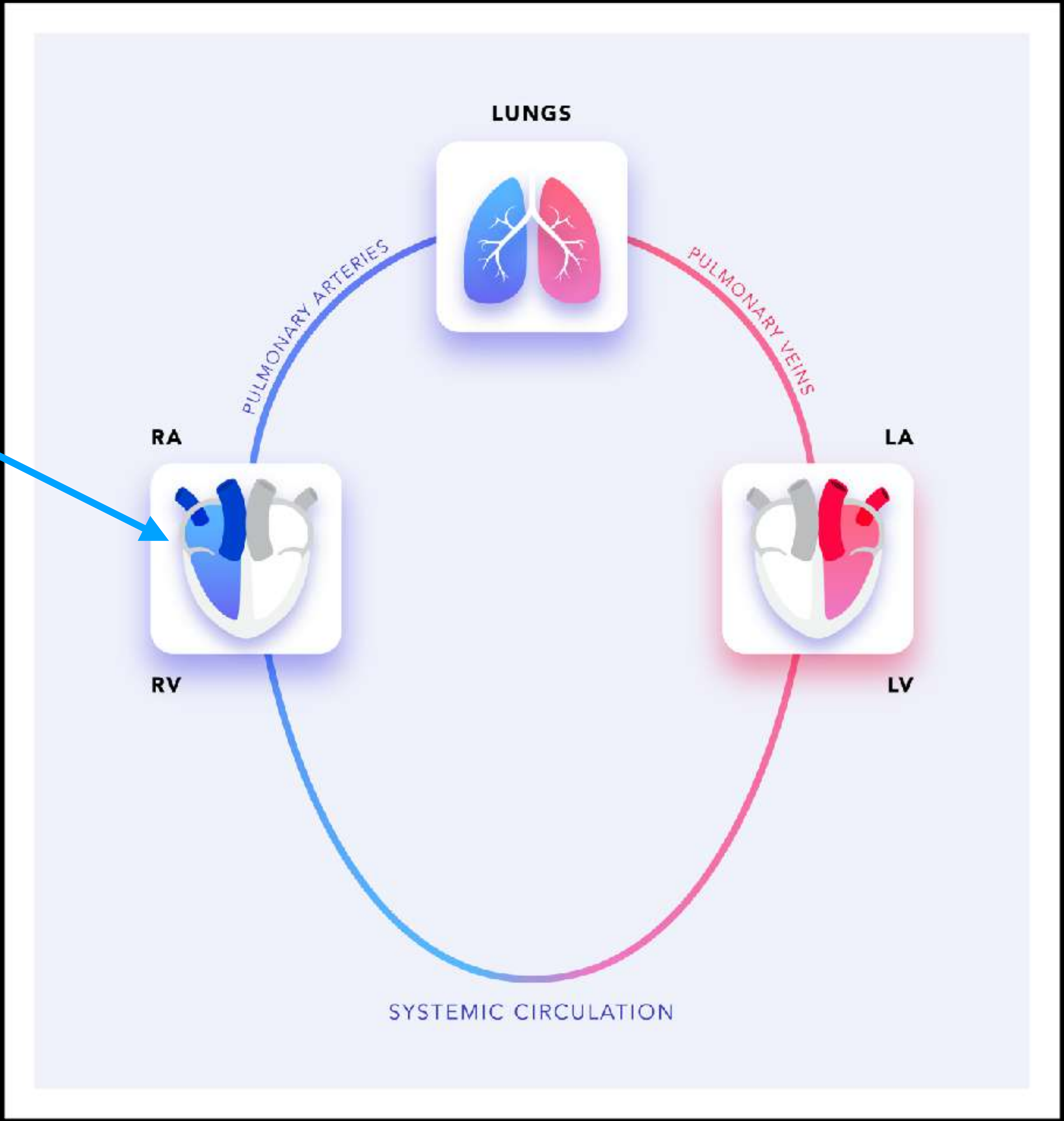
Setting: Medical intensive care ur
Créteil, France.

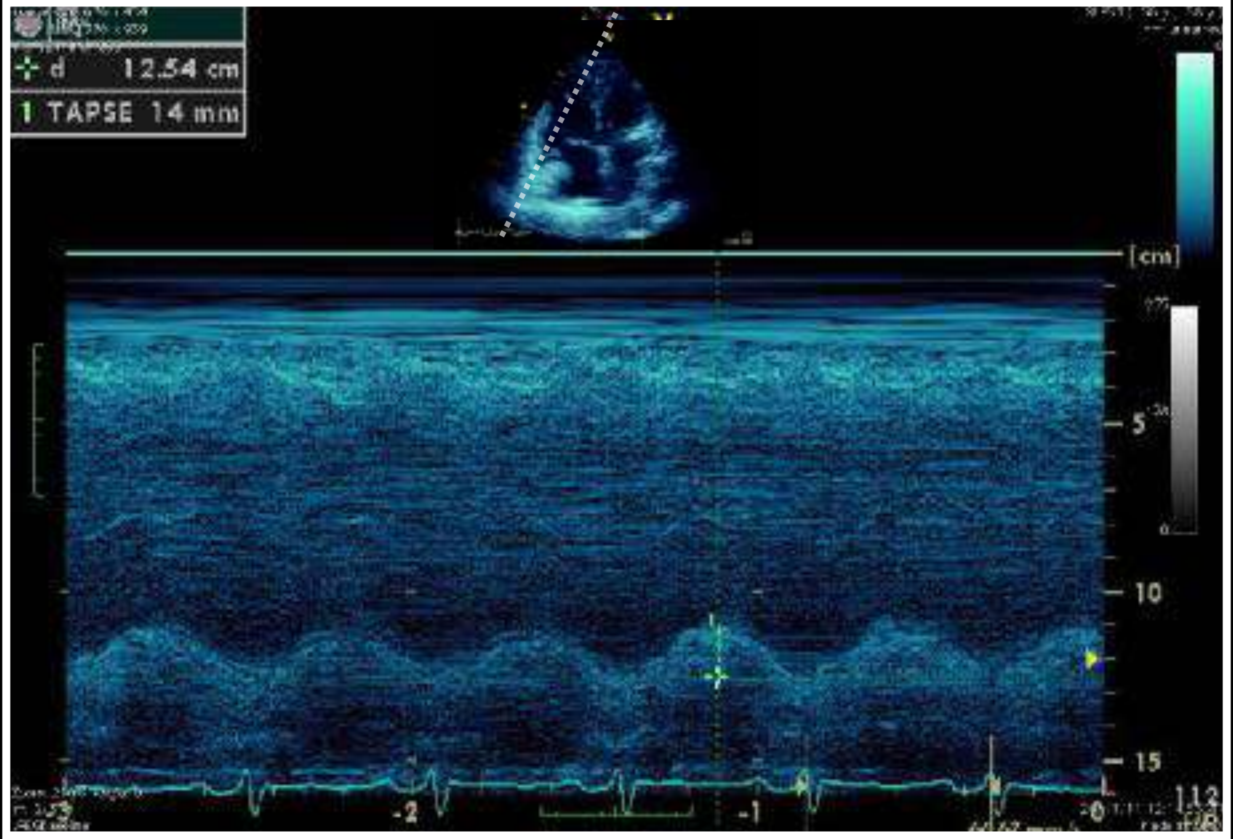
Patients: Two hundred three cons
respiratory distress syndrome.

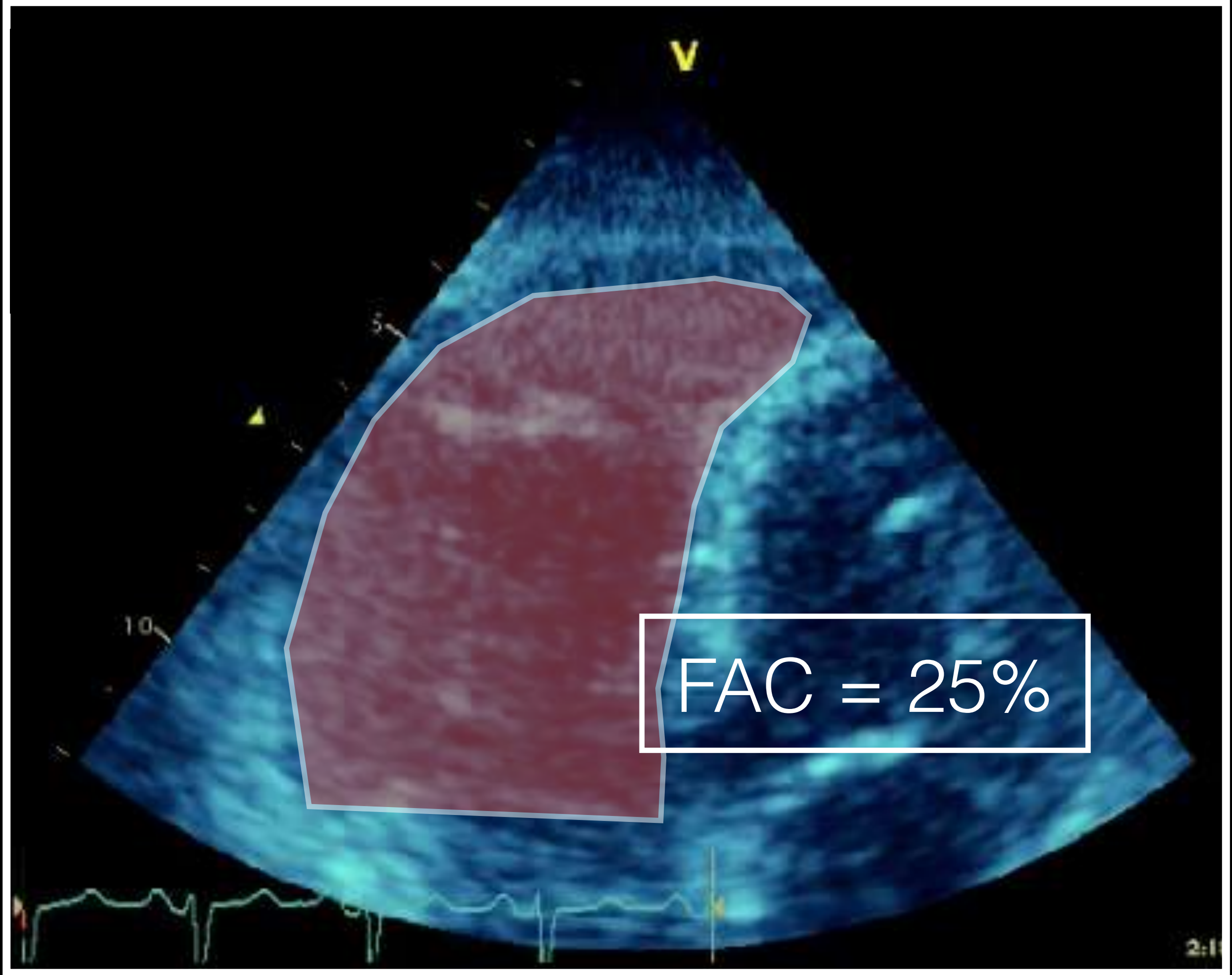
Interventions: Patent foramen ov
by using transesophageal echocard
atin contrast. Moderate-to-large
right-to-left passage of at least 10
like structure within three cardiac c
fication of the right atrium. In 85 pa
shunting, the influence of the positi
level on shunting was studied.

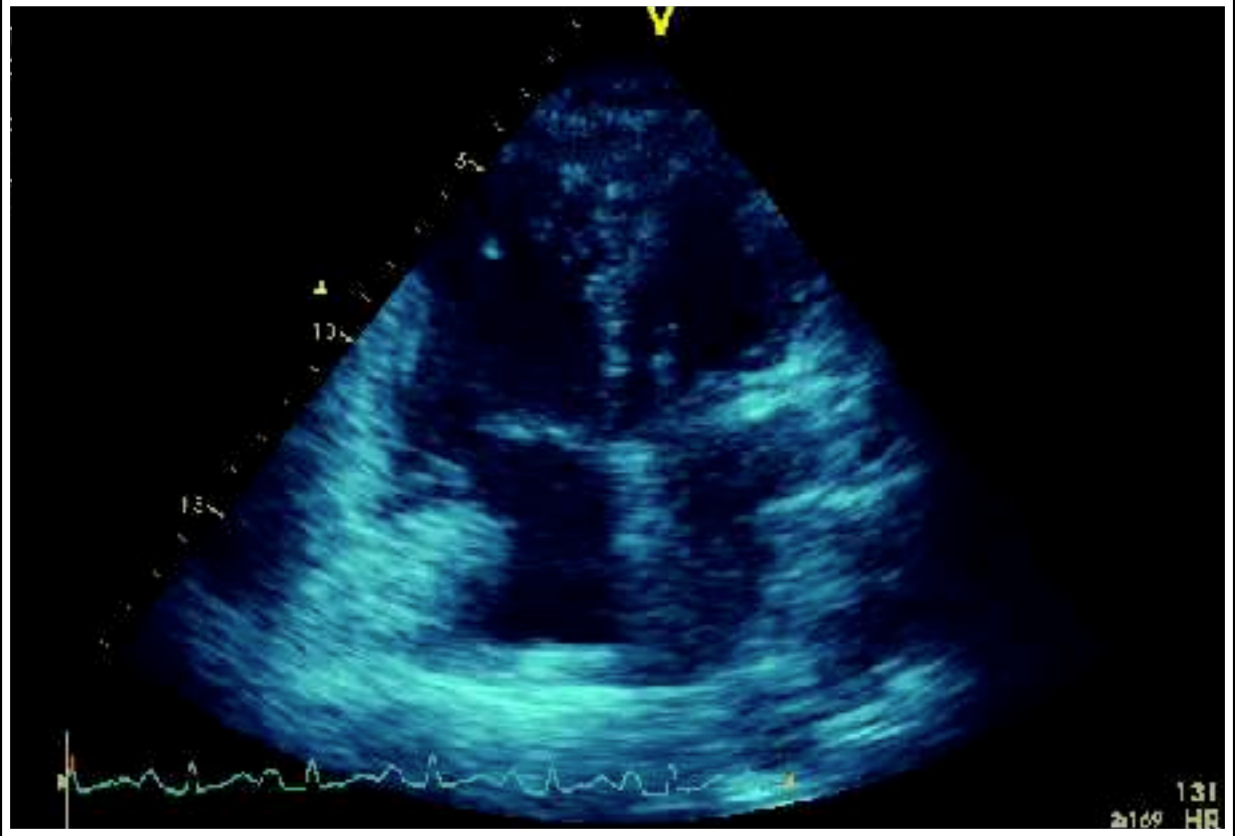
Measurements and Results: The prevalence of moderate-to-large patent foramen ovale shunting was 19.2% (39 patients). Compared to those in the group without shunting, the patients in group with shunting had larger right ventricle dimensions, higher pulmonary artery systolic pressure, and a higher prevalence of cor pulmonale. Compared to patients without shunting, patients with shunting

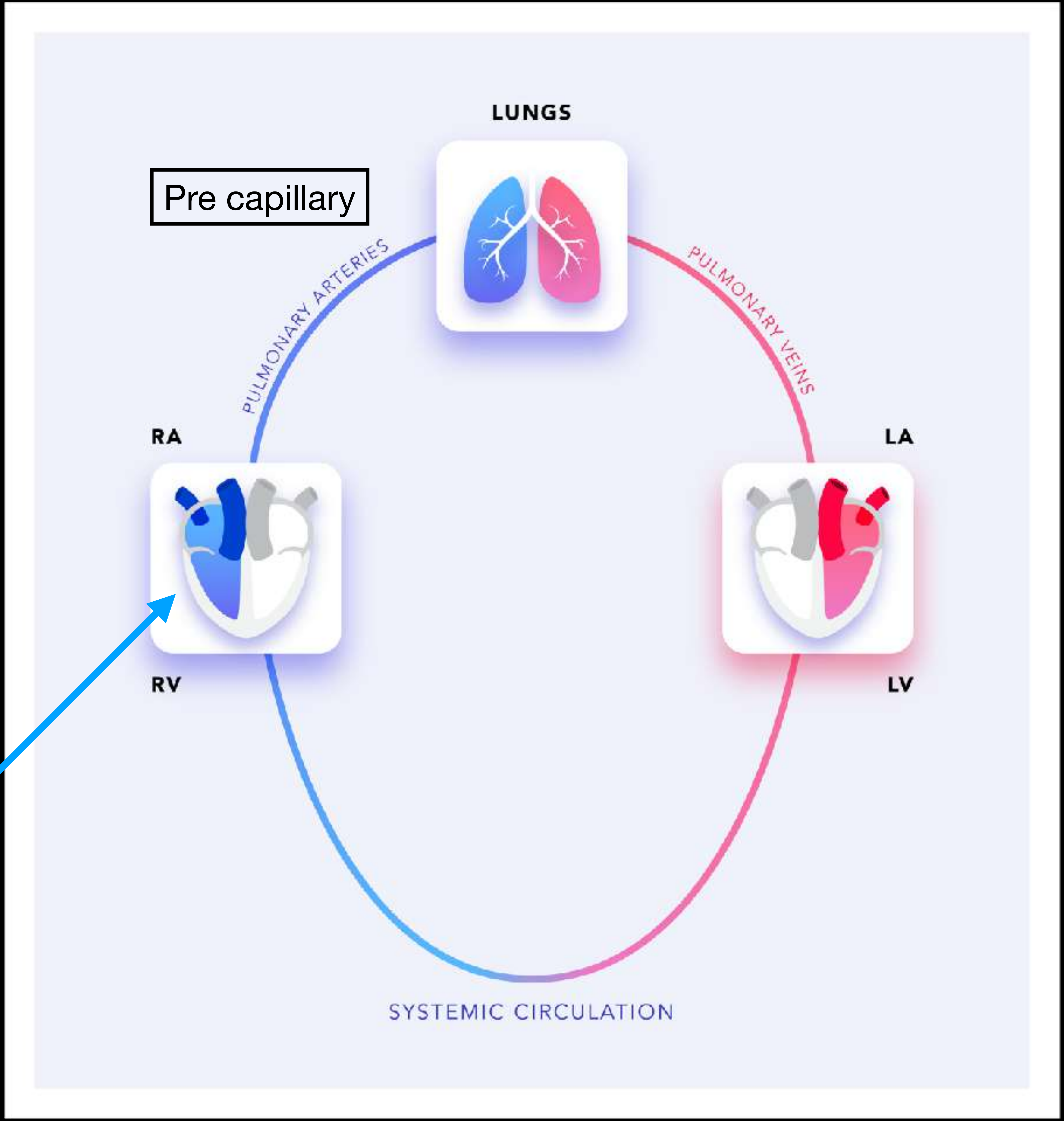
Conclusions: Moderate-to-large patent foramen ovale shunting occurred in 19.2% of patients with acute respiratory distress syndrome, in keeping with findings from autopsy studies. Patent foramen ovale was associated with a poor oxygenation response to positive end-expiratory pressure, greater use of adjunctive interventions, and a longer intensive care unit stay. (Crit Care Med 2010; 38:1786–1792)




d 12.54 cm
1 TAPSE 14 mm


FAC = 25%




LUNGS
Pre capillary
PULMONARY ARTERIES
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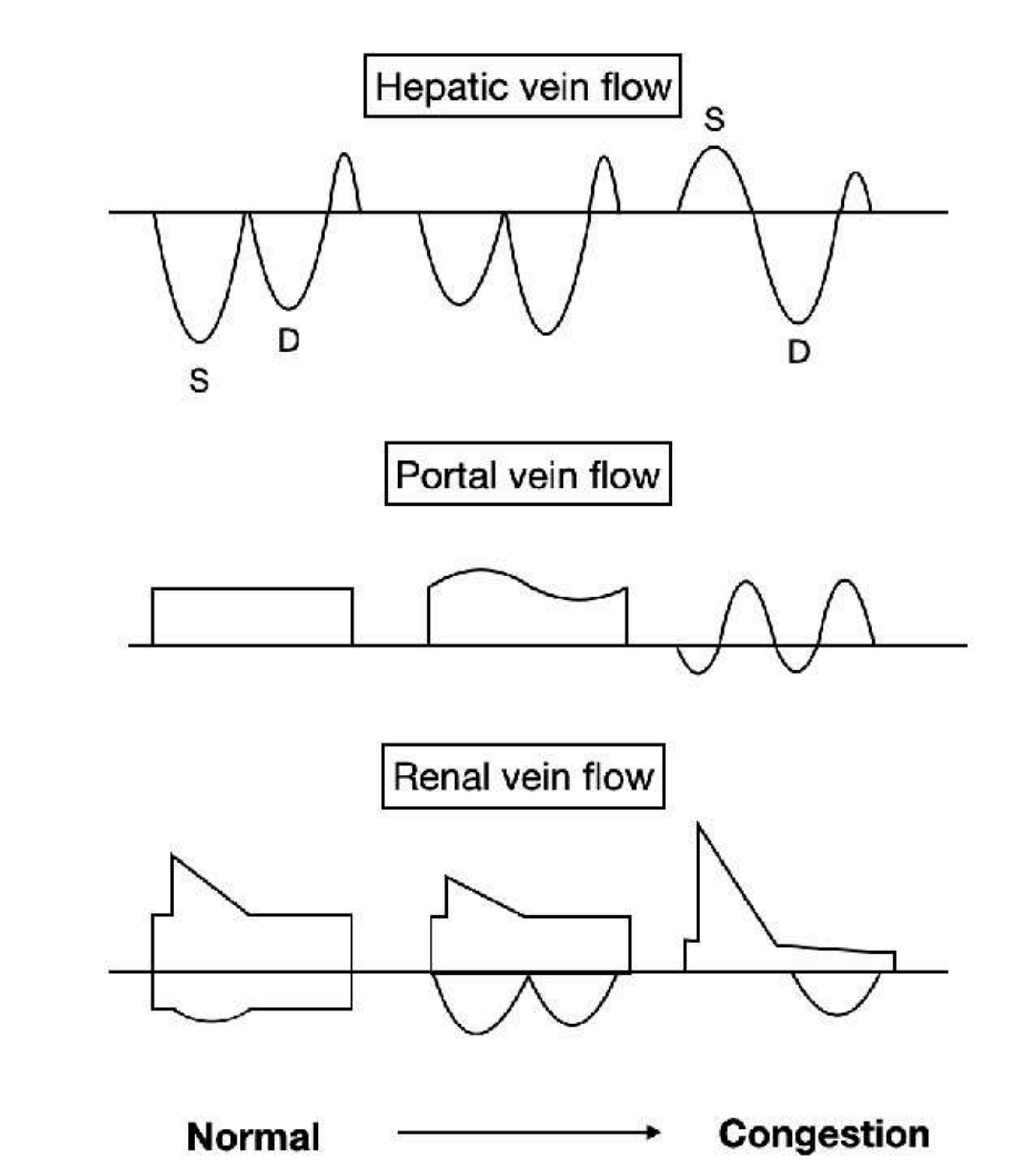
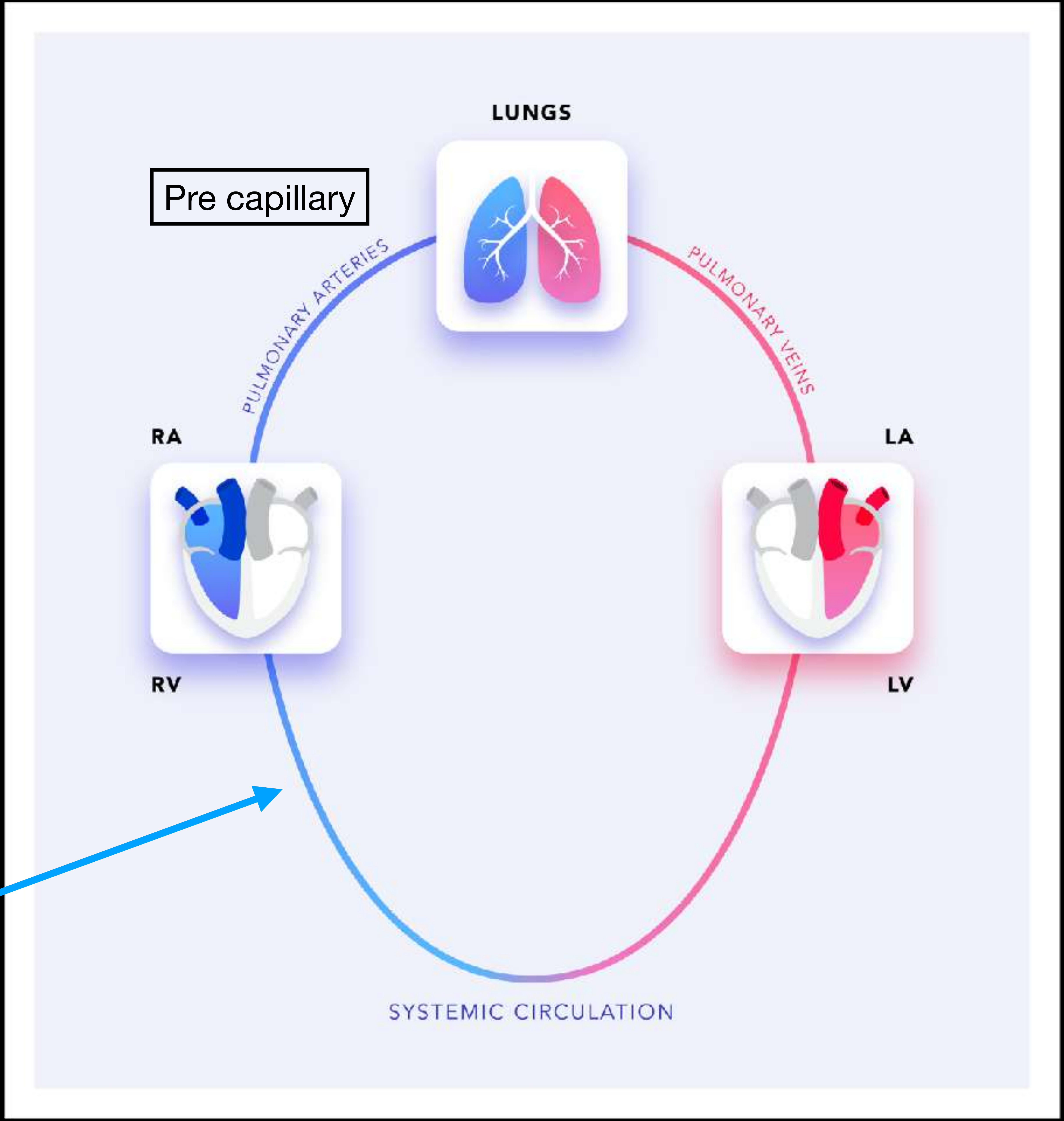
VExUS

(**VE**nous E**x**cess **U**ltra**S**ound)





Mechanical ventilation
Induced failure

Pre-capillary
Pulmonary hypertension

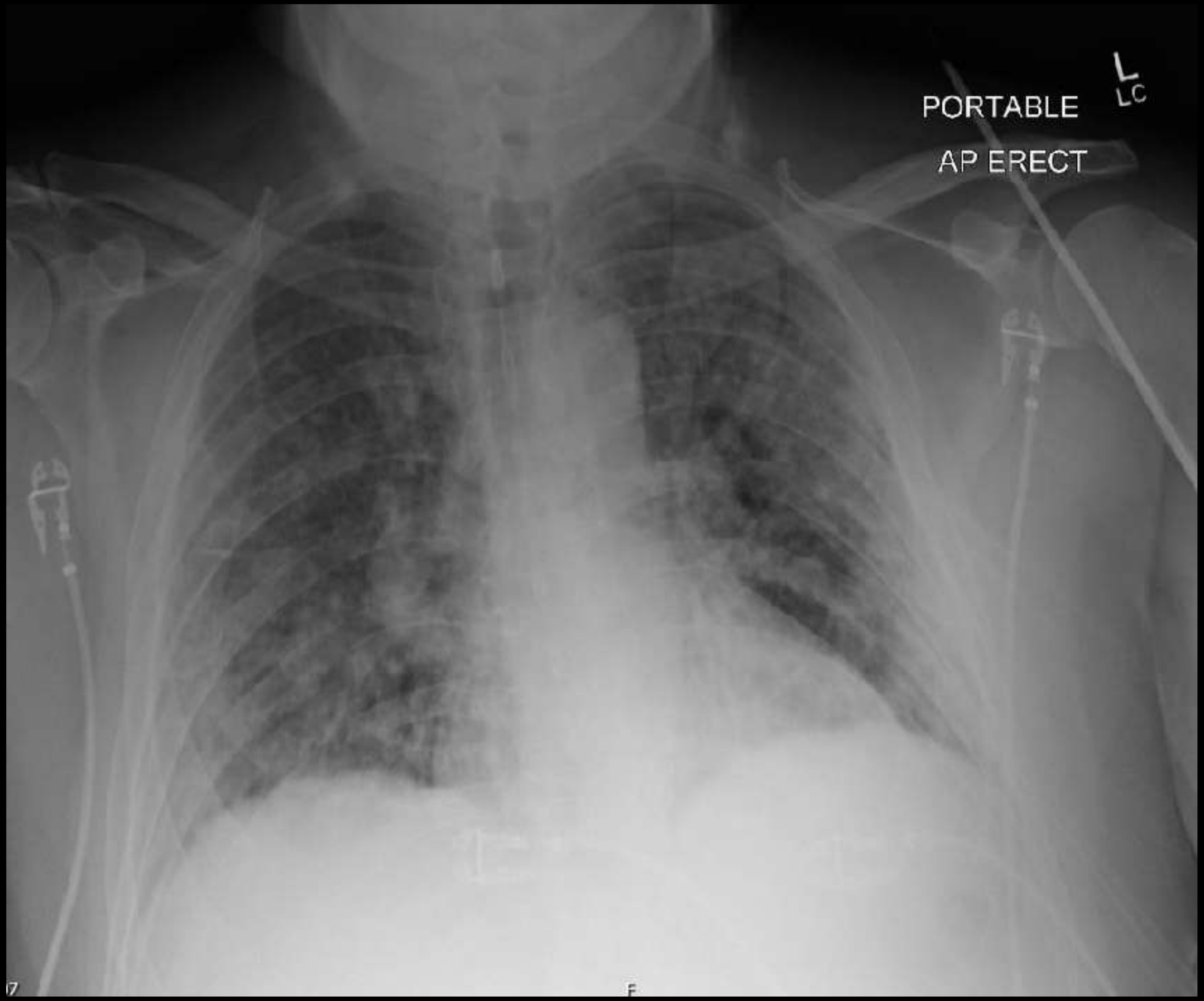
Post capillary
Pulmonary
hypertension

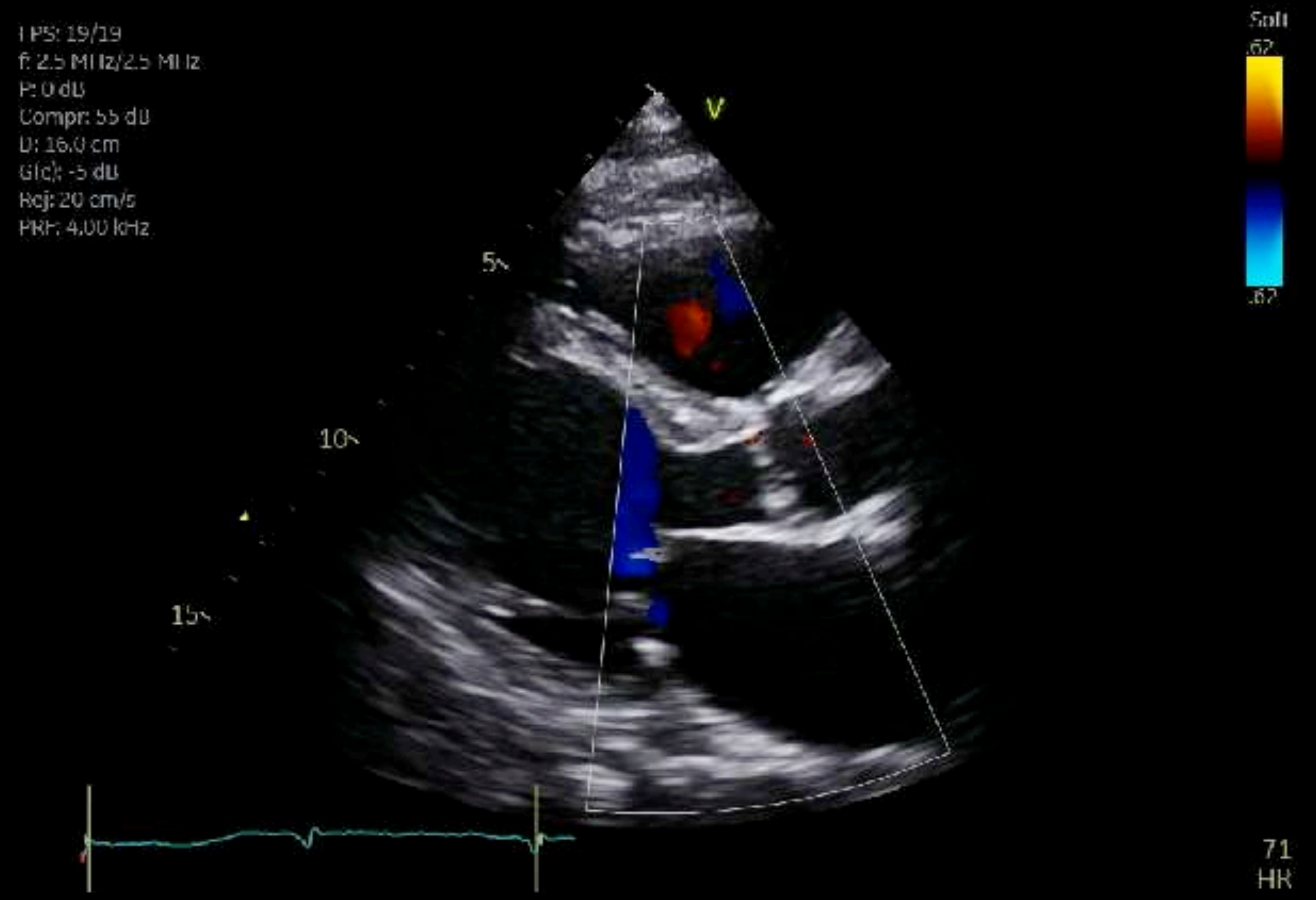
Respiratory failure phenotypes

Post capillary Pulmonary hypertension

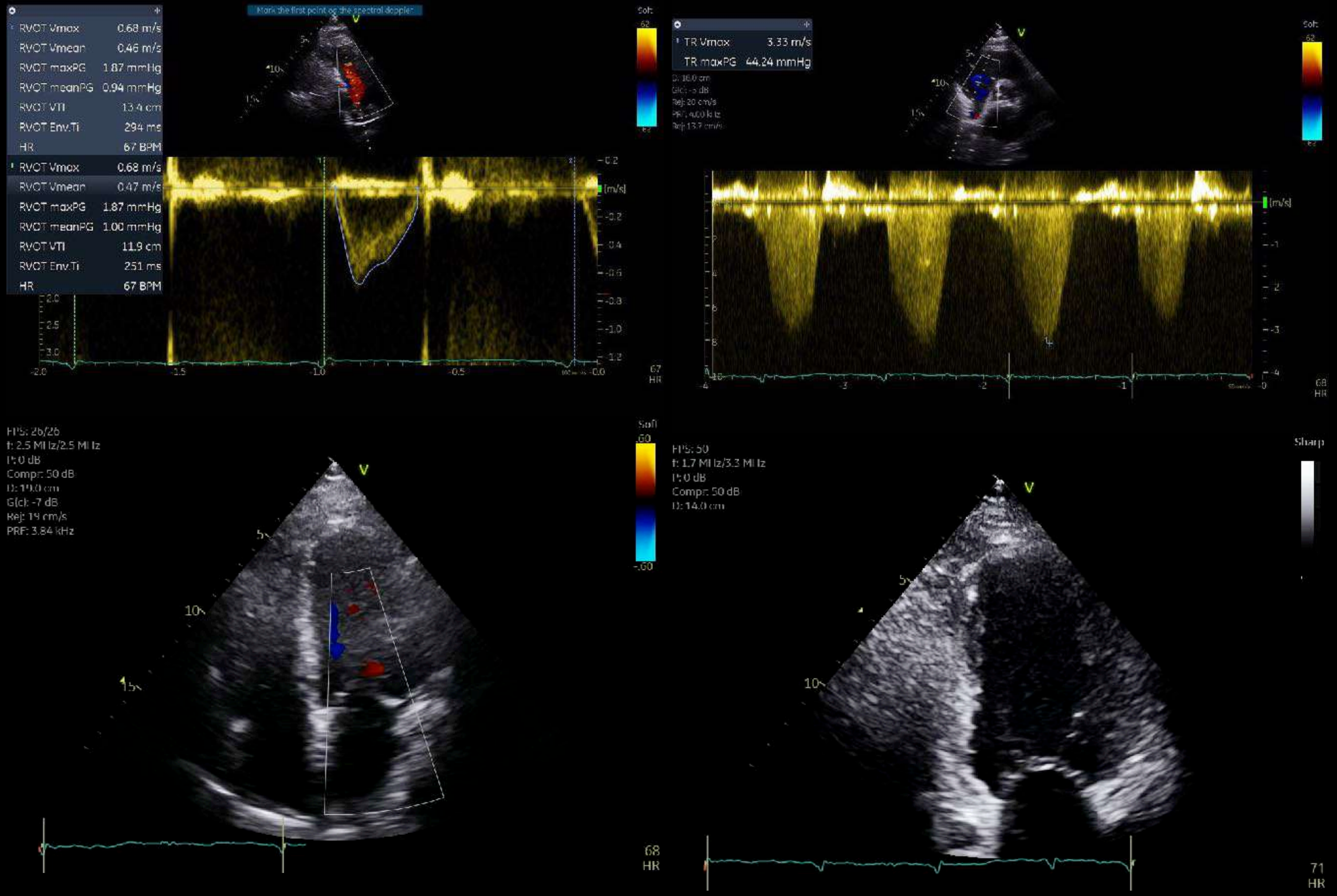
45 yo male.
PMH renal transplant

MET call to respiratory ward
2 days in hospital with Dx ? PJP pneumonia
SOB over last 48hours worsening





ECHO AUSTRALIA



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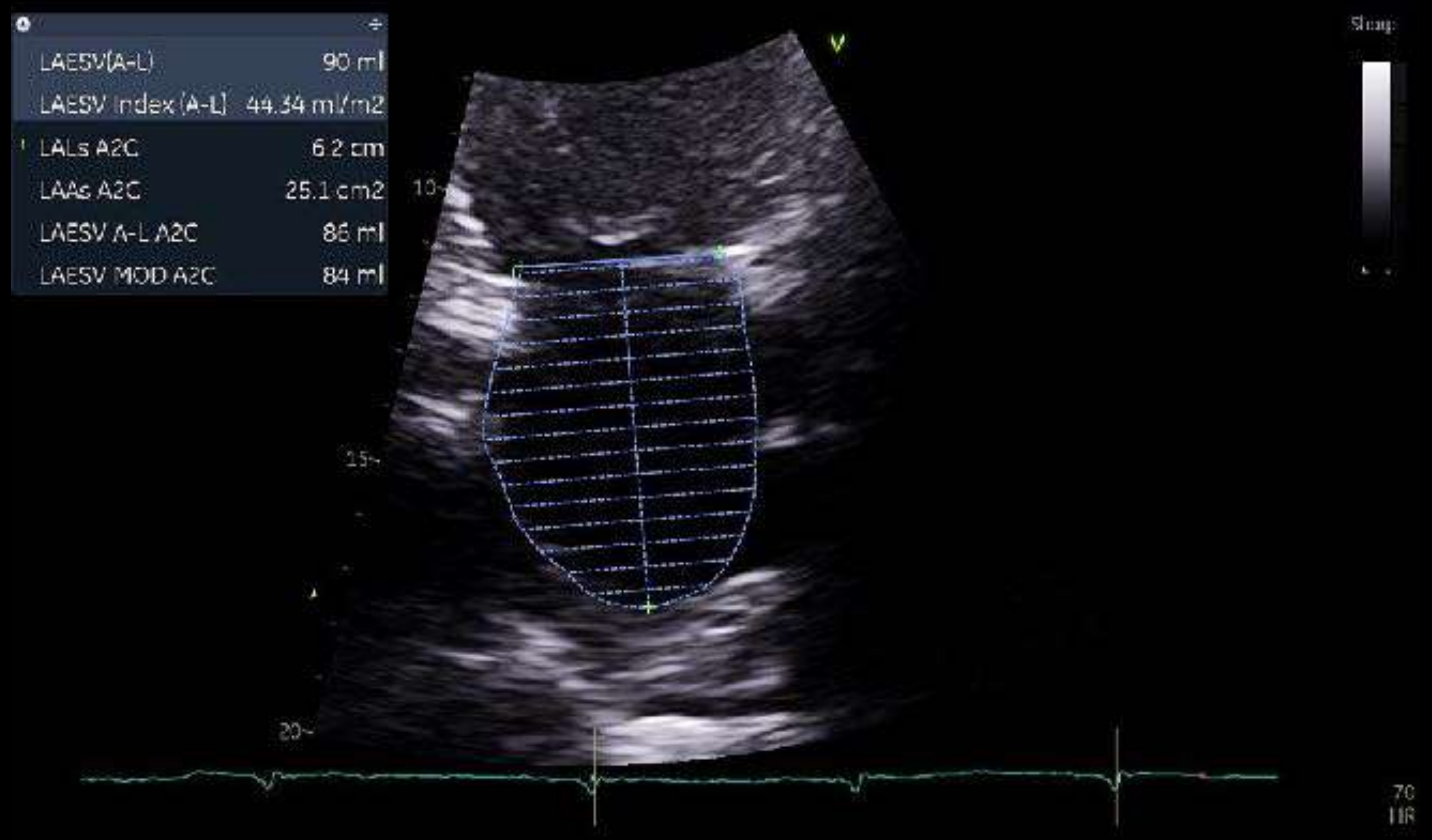

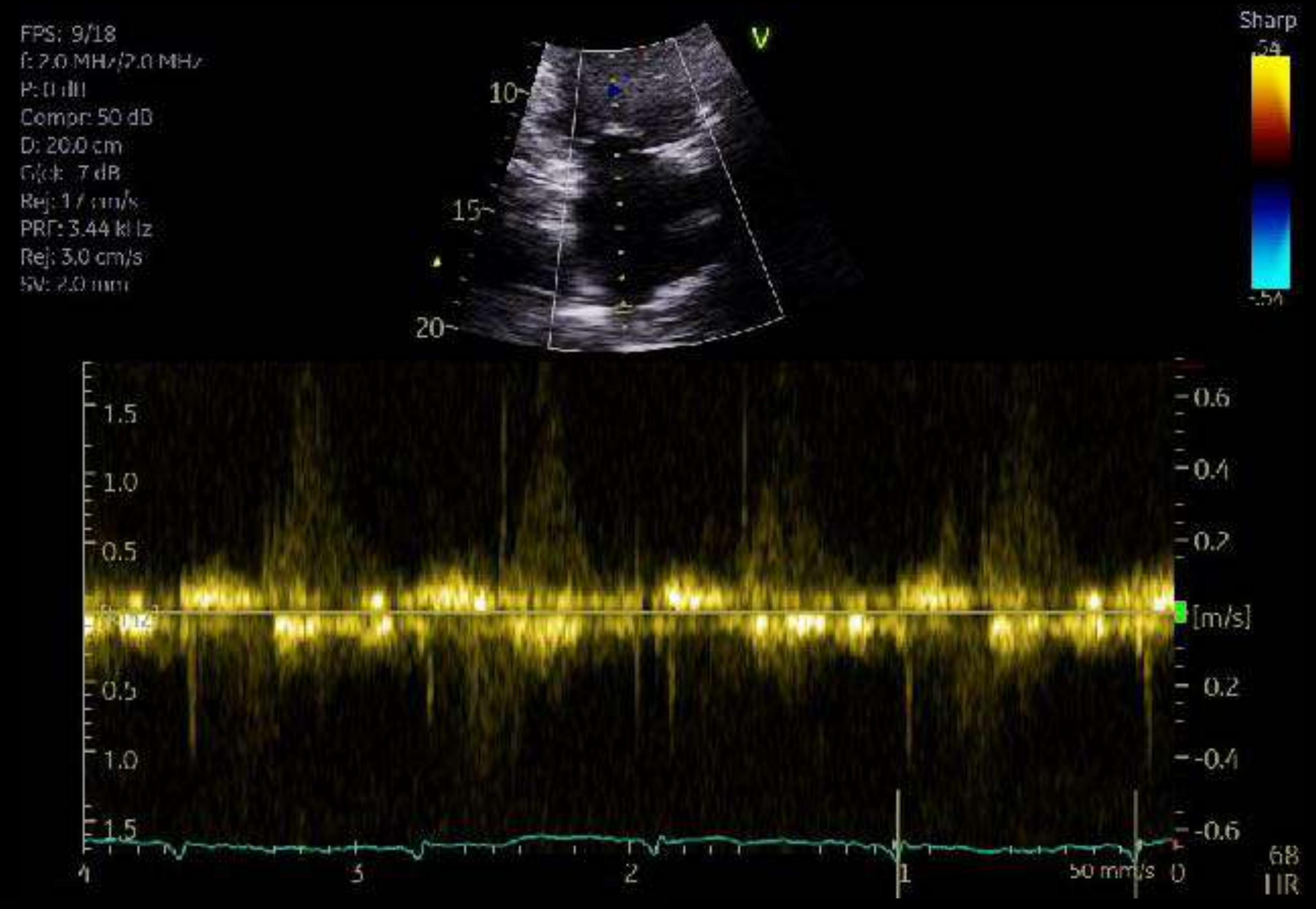

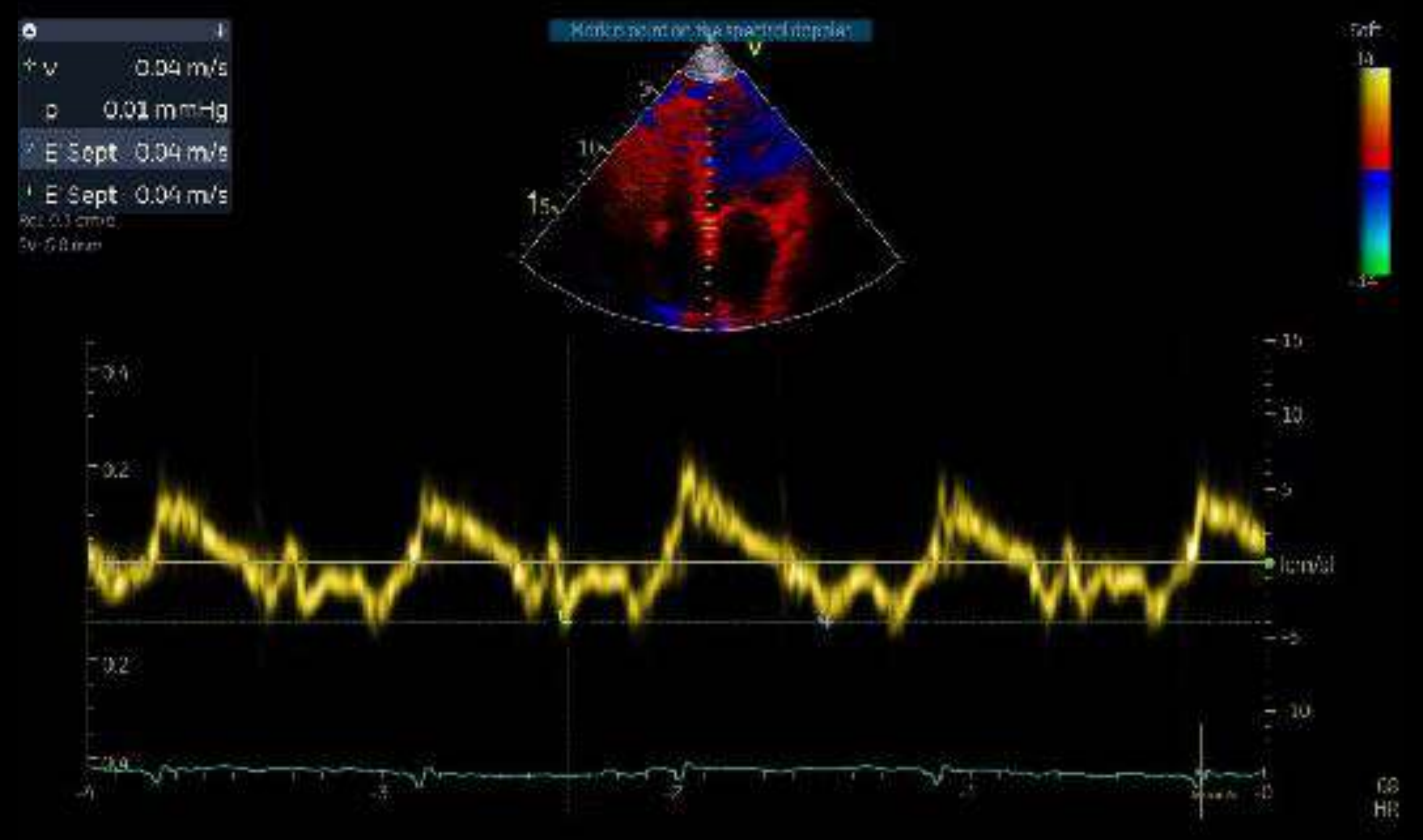

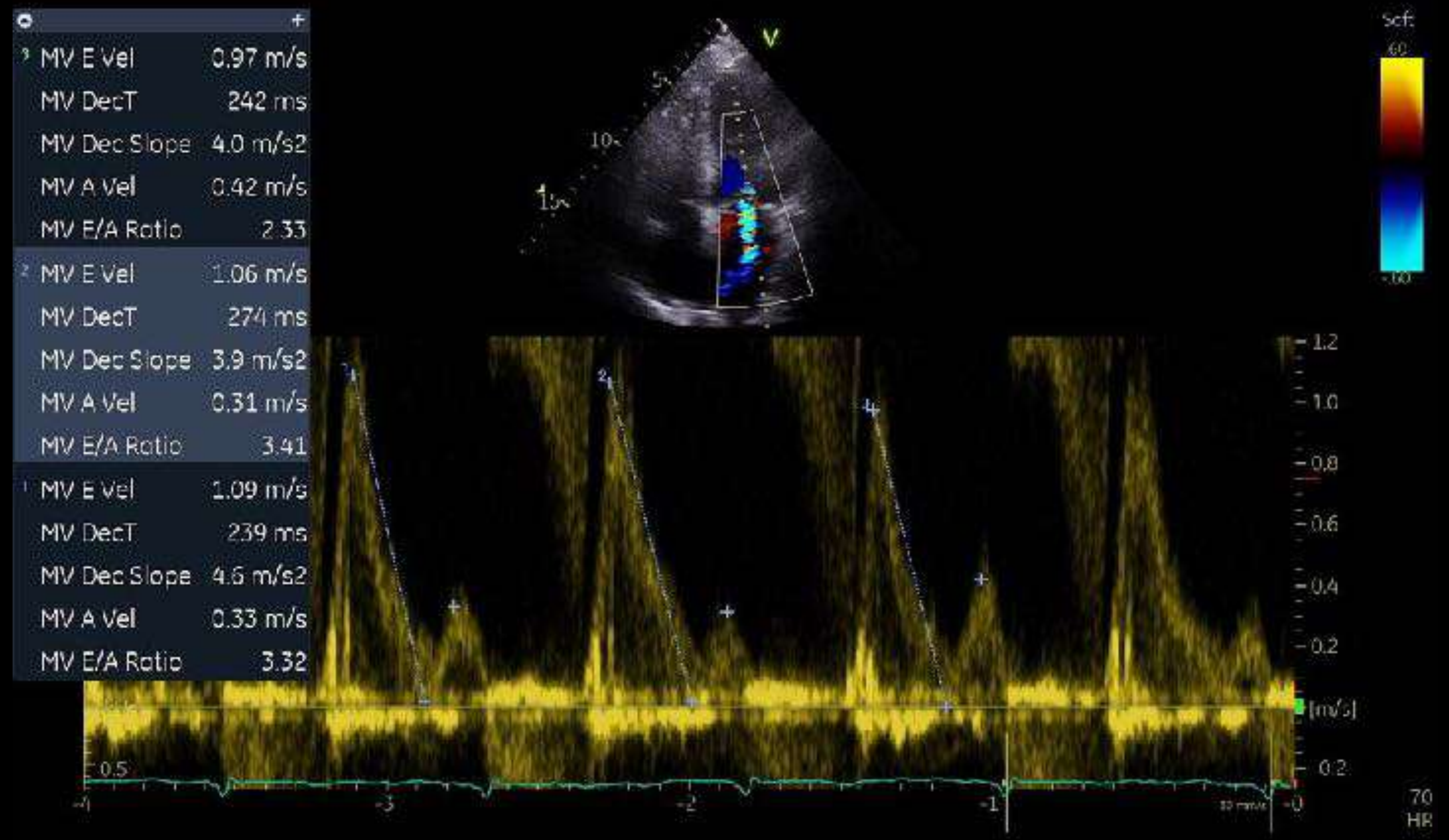

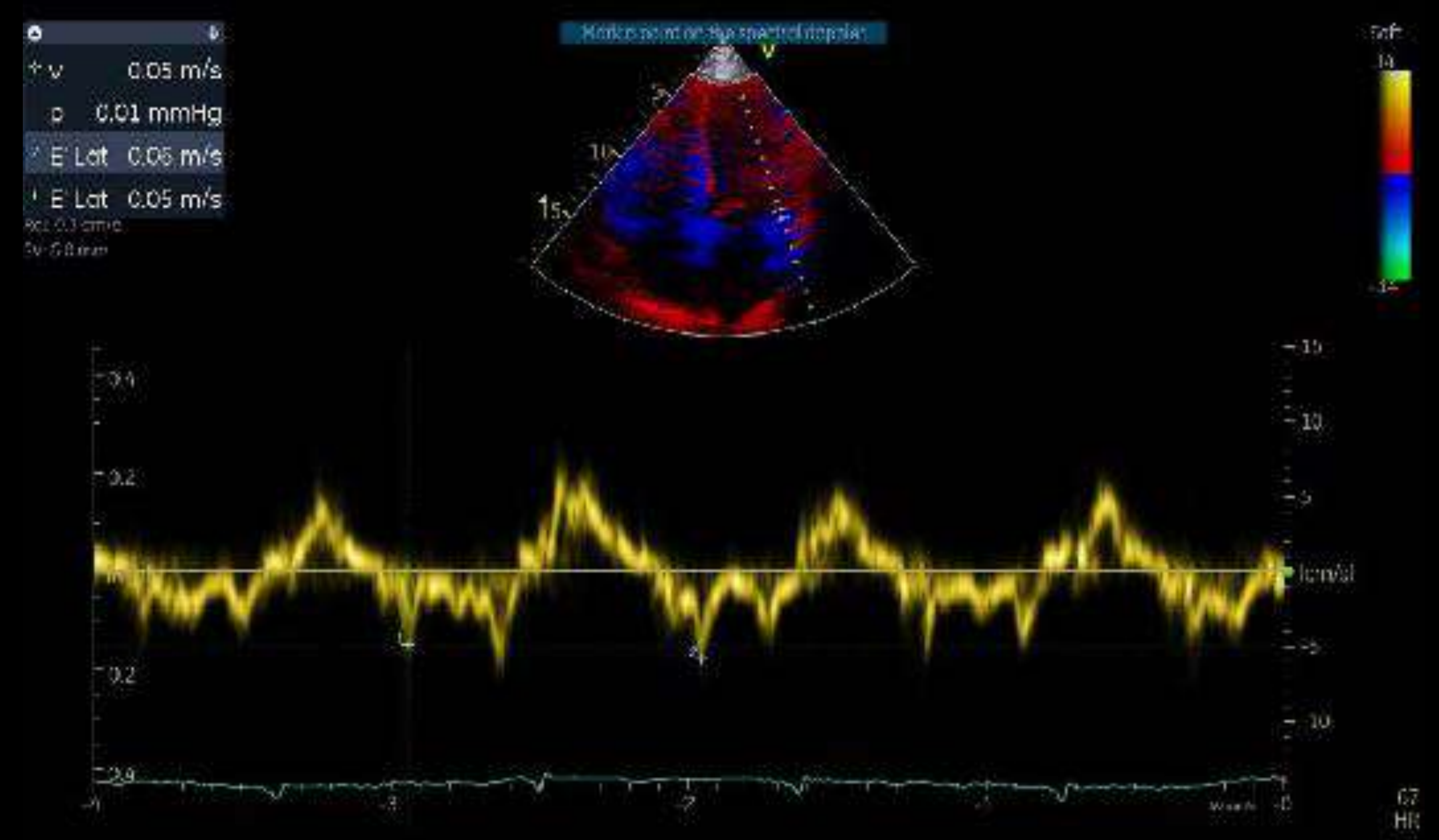

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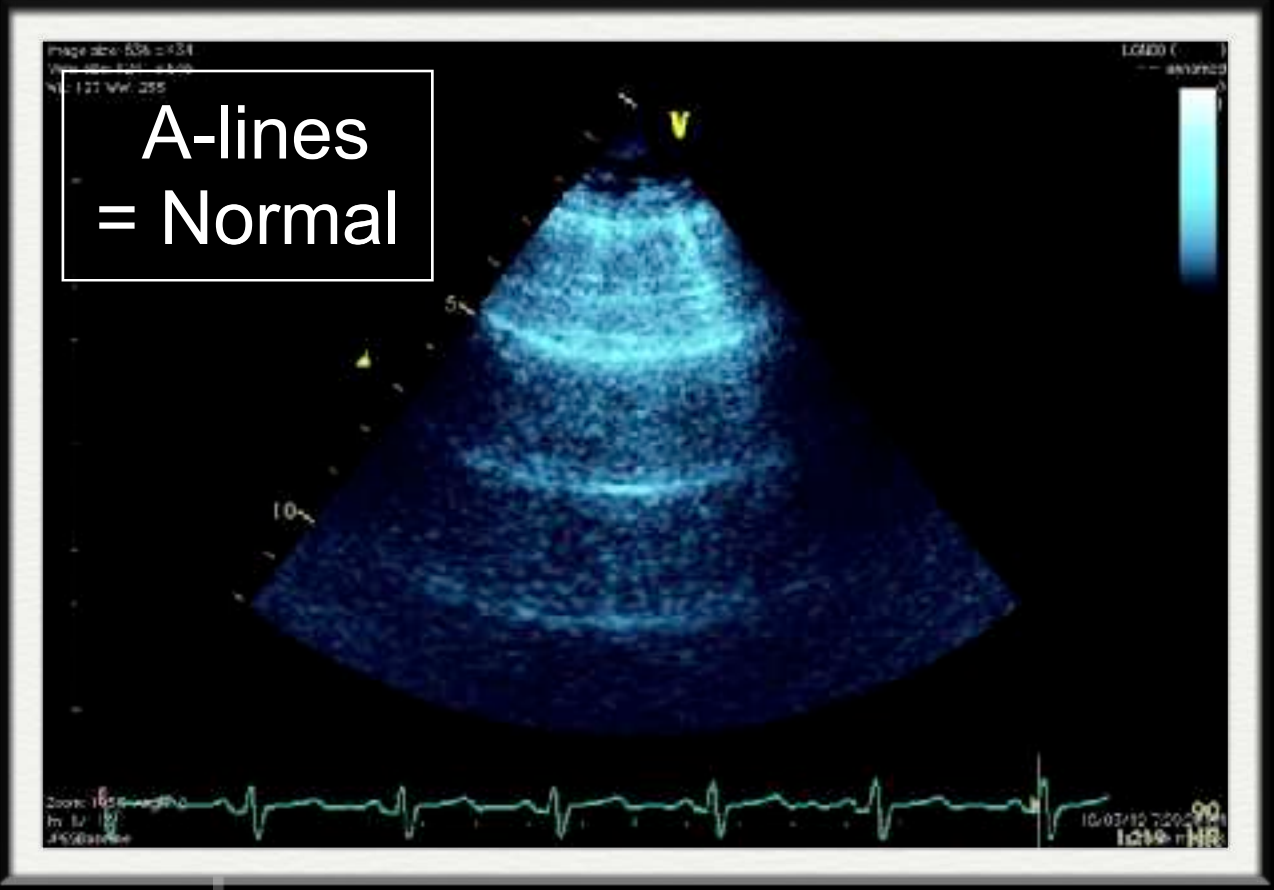

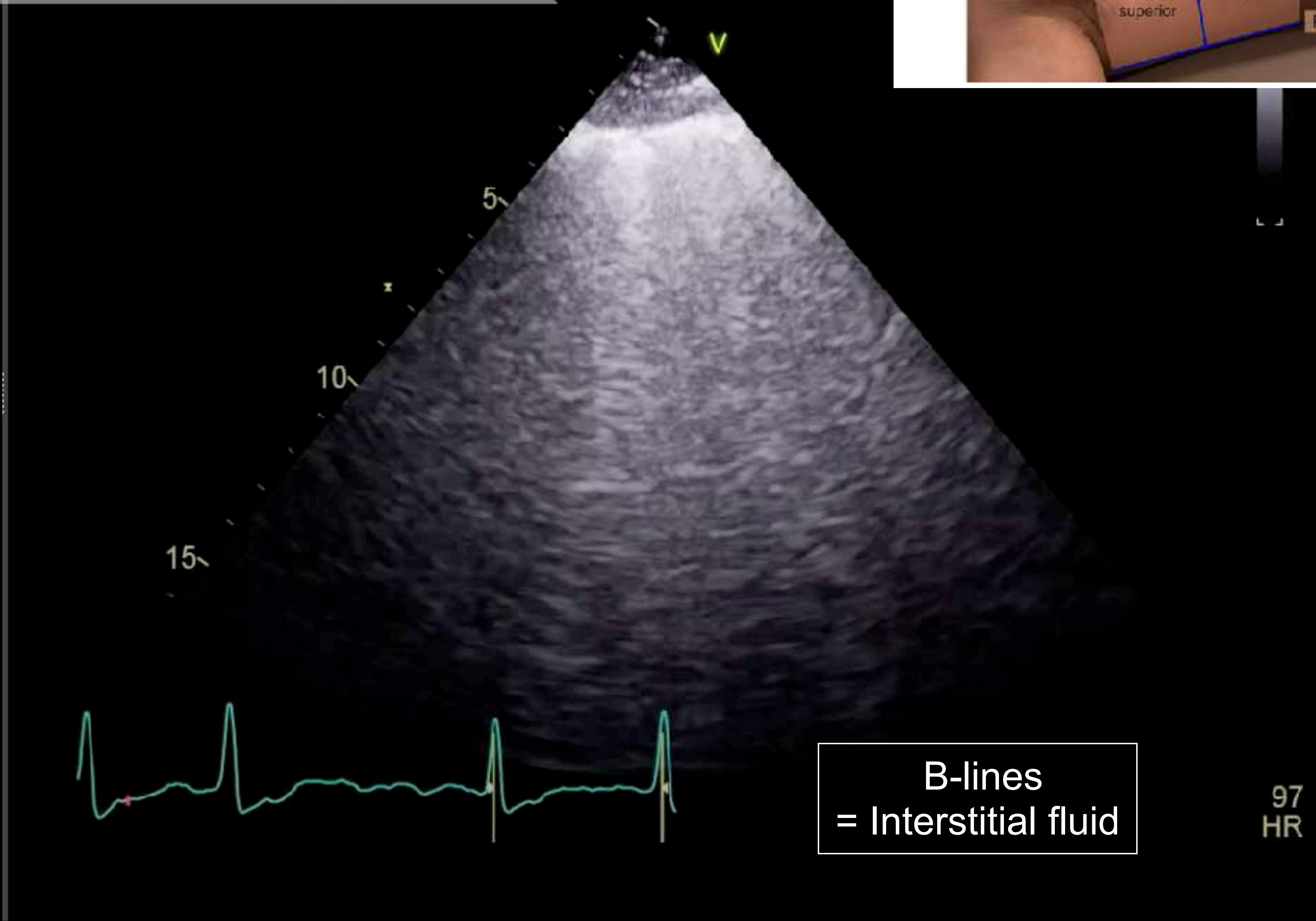

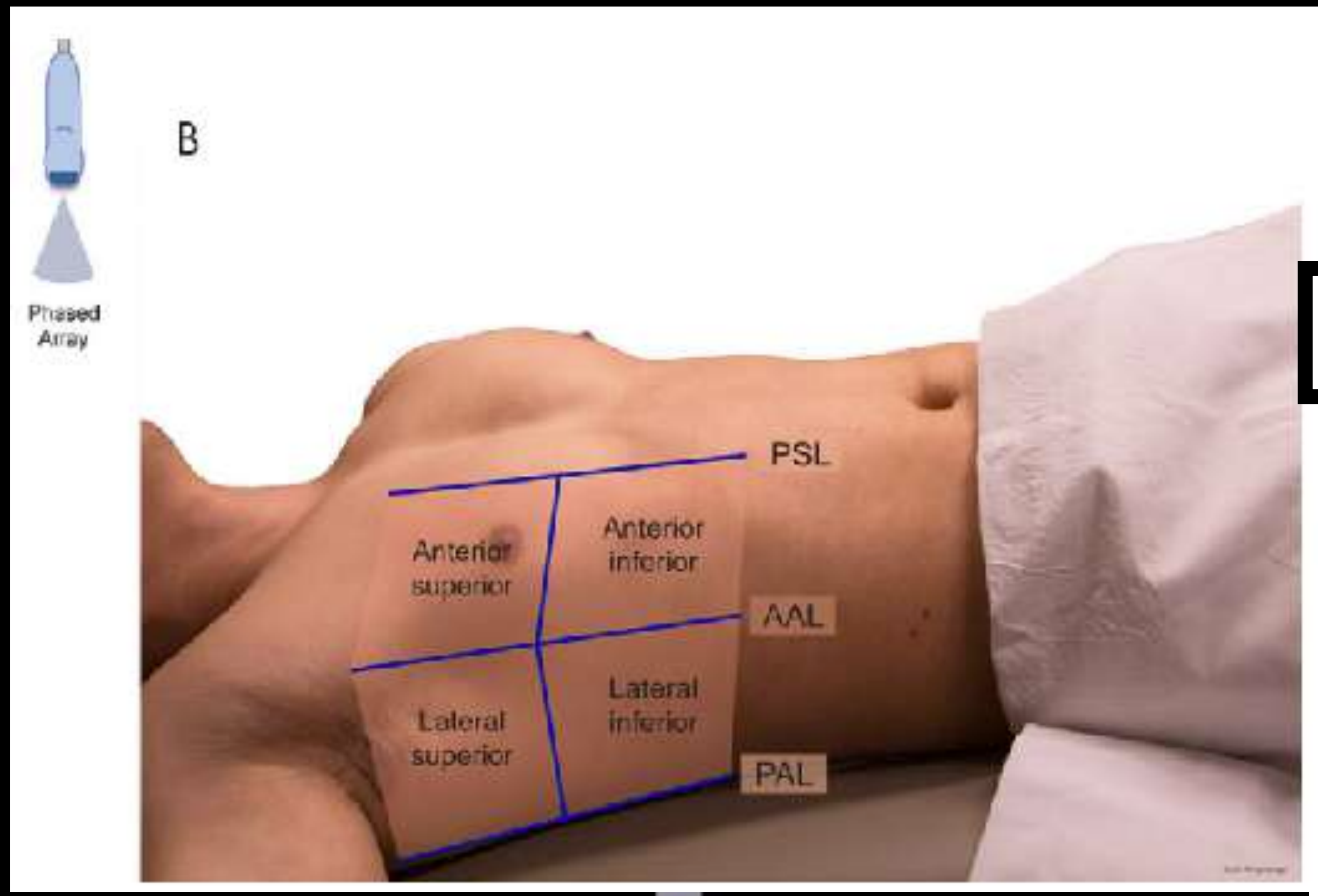

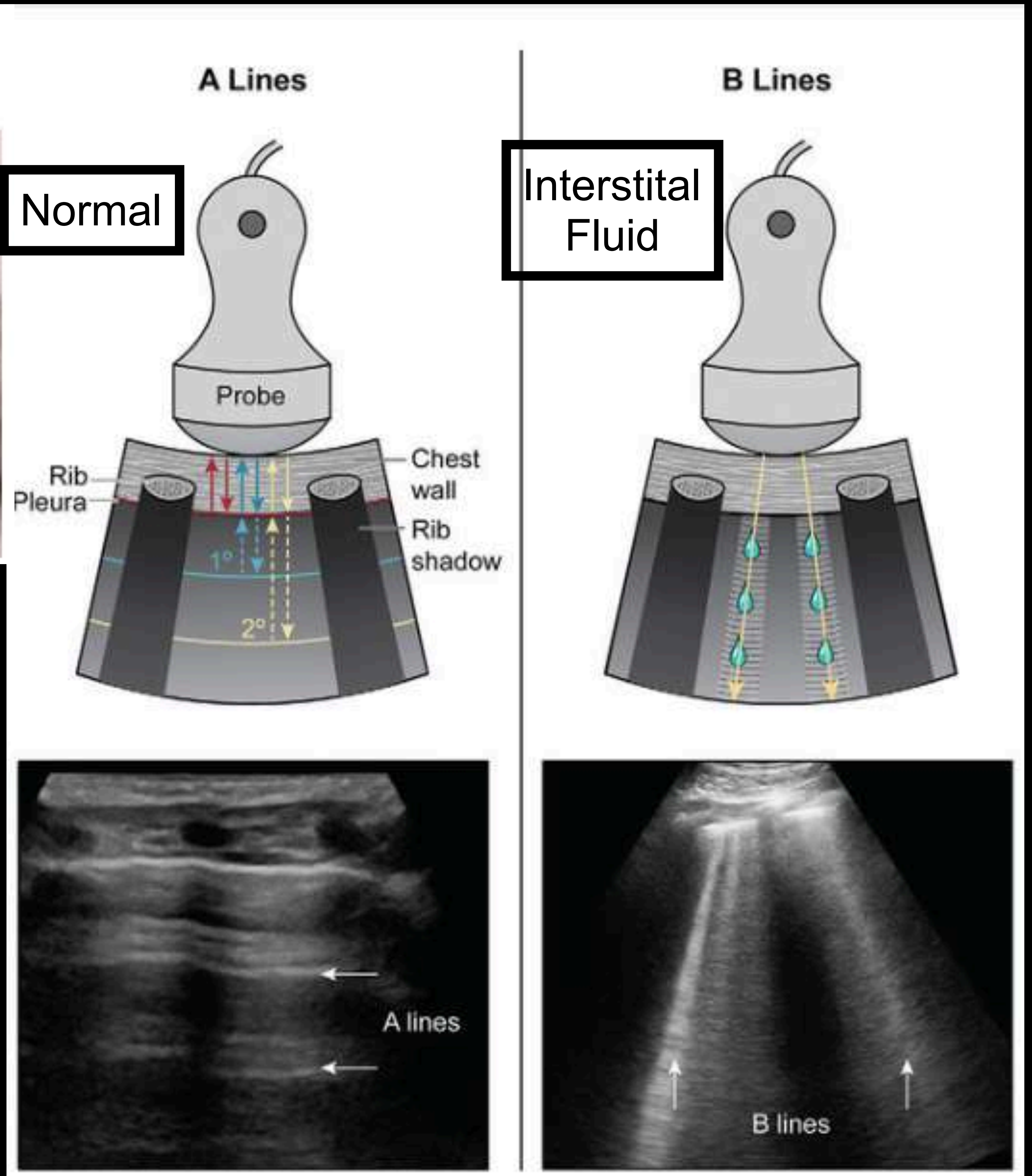

Radiology: Cardiothoracic Imaging
IMAGING ESSAY

Lung Ultrasound: The Essentials

Thomas J. Marini, MD • Deborah J. Rubens, MD • Yu T. Zhao, BA • Justin Weis, MD • Timothy P. O'Connor, MD • William H. Novak, MD • Katherine A. Kaproth-Joslin, MD, PhD

Radiology: Cardiothoracic Imaging 2021; 3(2):e200564 • https://doi.org/10.1148/ryct.2021200564 •

Thoughts …

LV moderately impaired + significant MR

Raised left atrial pressure.

=> Pulmonary oedema

Impression = Post capillary contribution to respiratory failure

Plan = Diuresis

PEEP (eg: NIV or intubation) = reduce LV preload, reduced LV afterload

Mechanical ventilation
Induced failure

Pre-capillary
Pulmonary hypertension

Post capillary
Pulmonary
hypertension

Respiratory failure phenotypes

74yoM PC = Unwell SOB++. PMH: HFPEF, pulmonary hypertension, ex-smoker
Imp = Septic shock ? Pneumonia
Issues: AKI with oliguria. Lactate 4. Mild LFT derangement.

Pre-capillary
Pulmonary hypertension

Treatment so far in ED = 2L IVF, Noradrenaline at 15mcg/hr.
Broad spectrum IV antibiotics and cultures

74yoM PC = Unwell SOB++. PMH: HFPEF, pulmonary hypertension, ex-smoker
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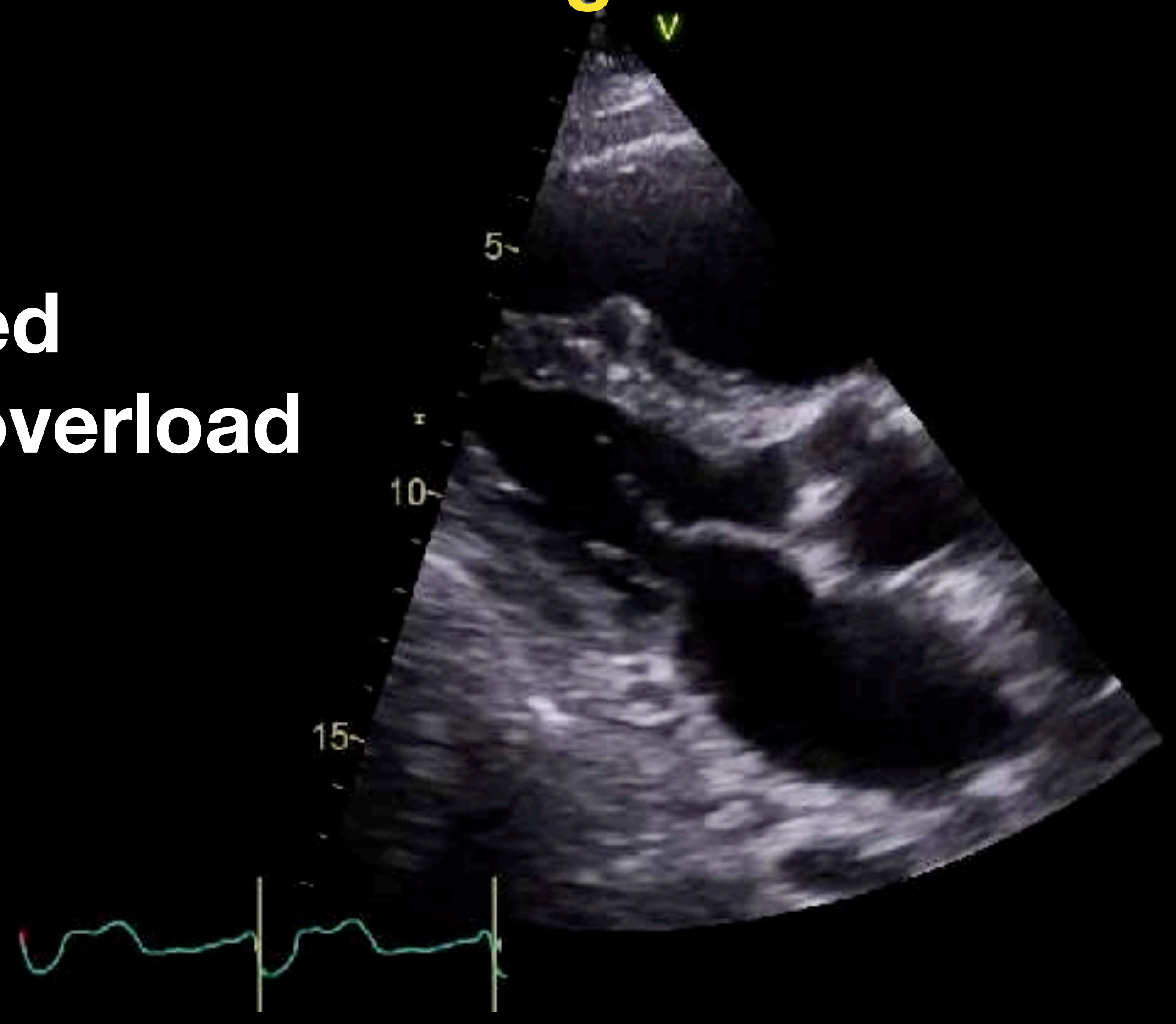
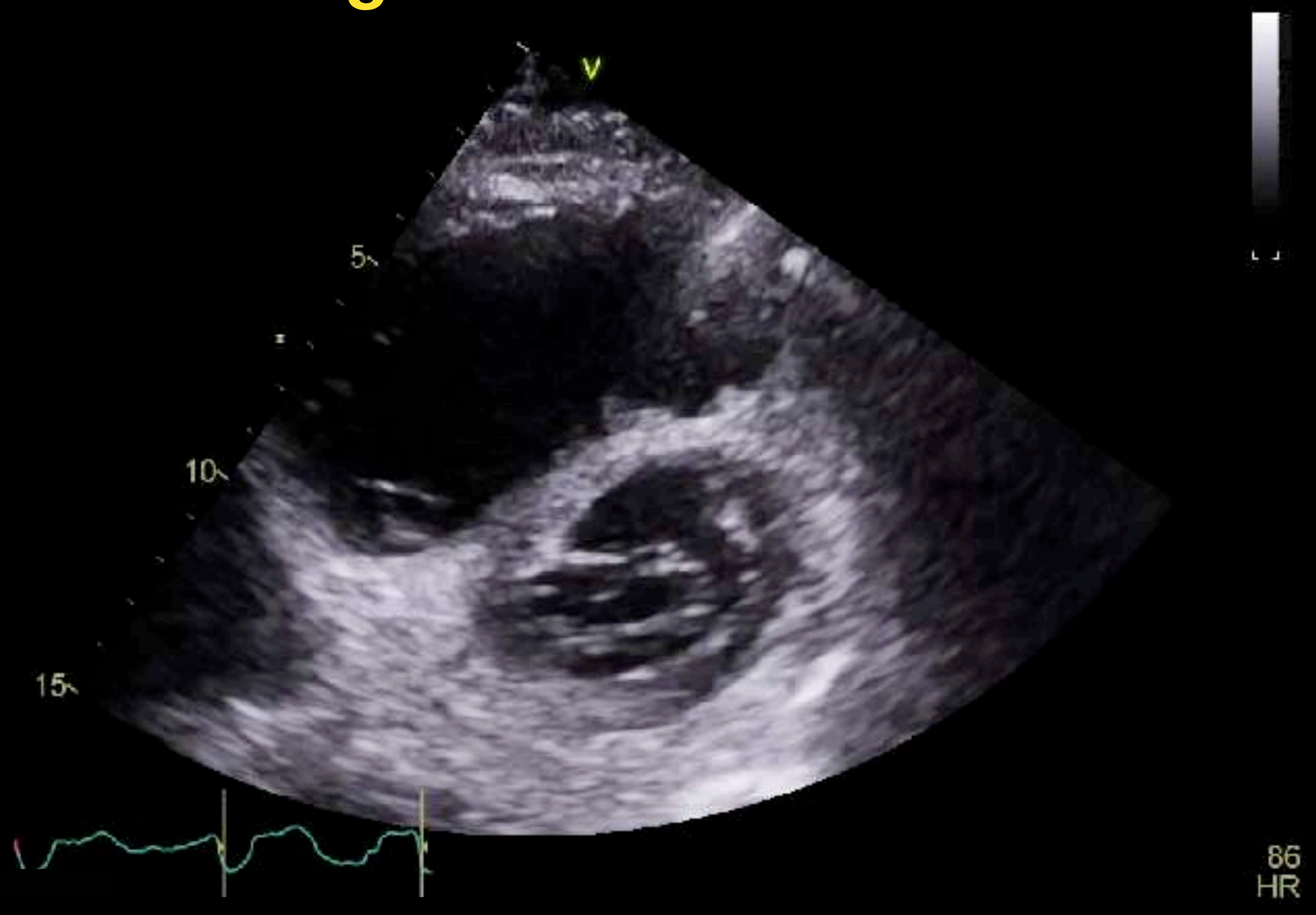
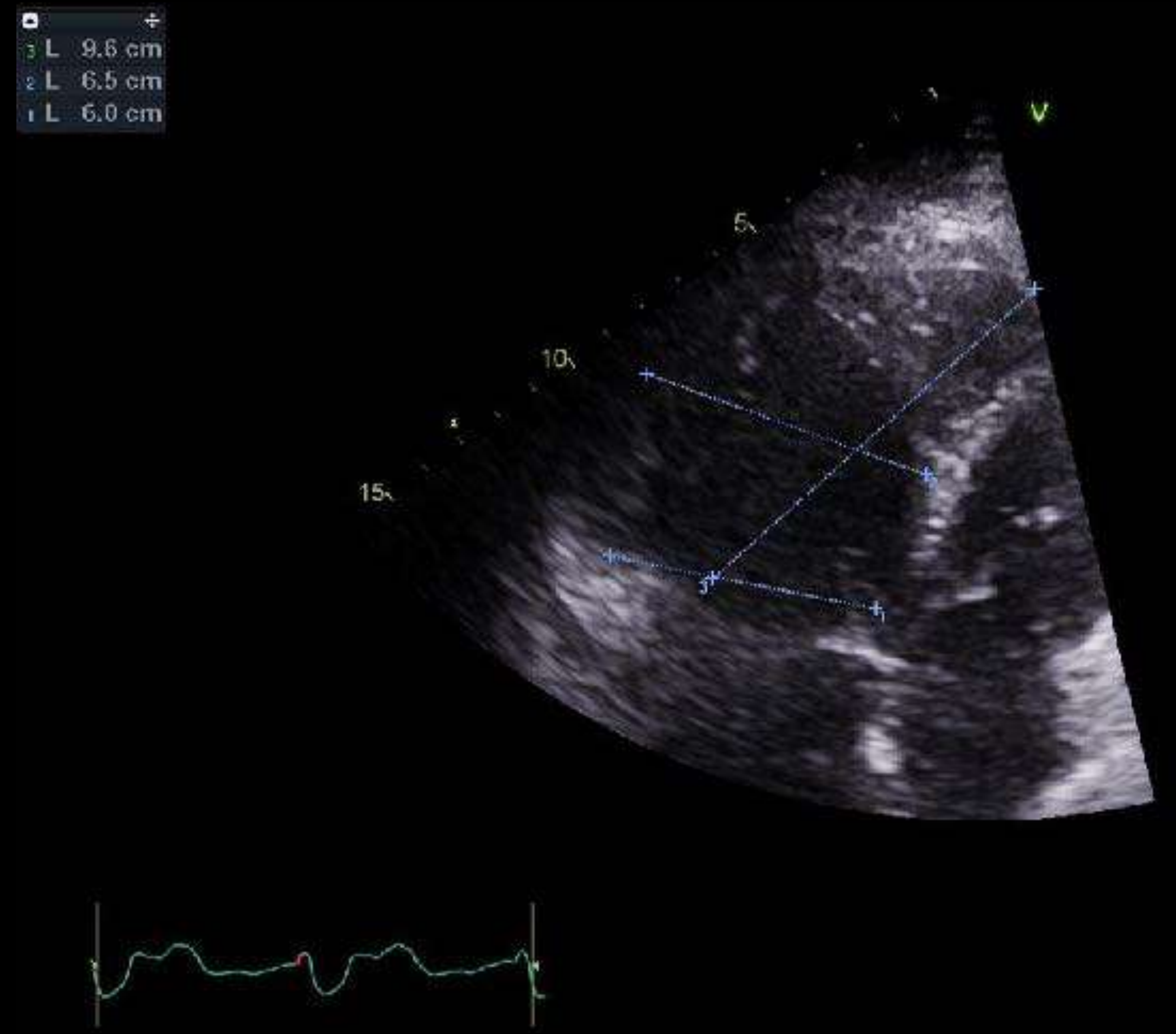
Issues: AKI with oliguria. Lactate 4. Mild LFT derangement.

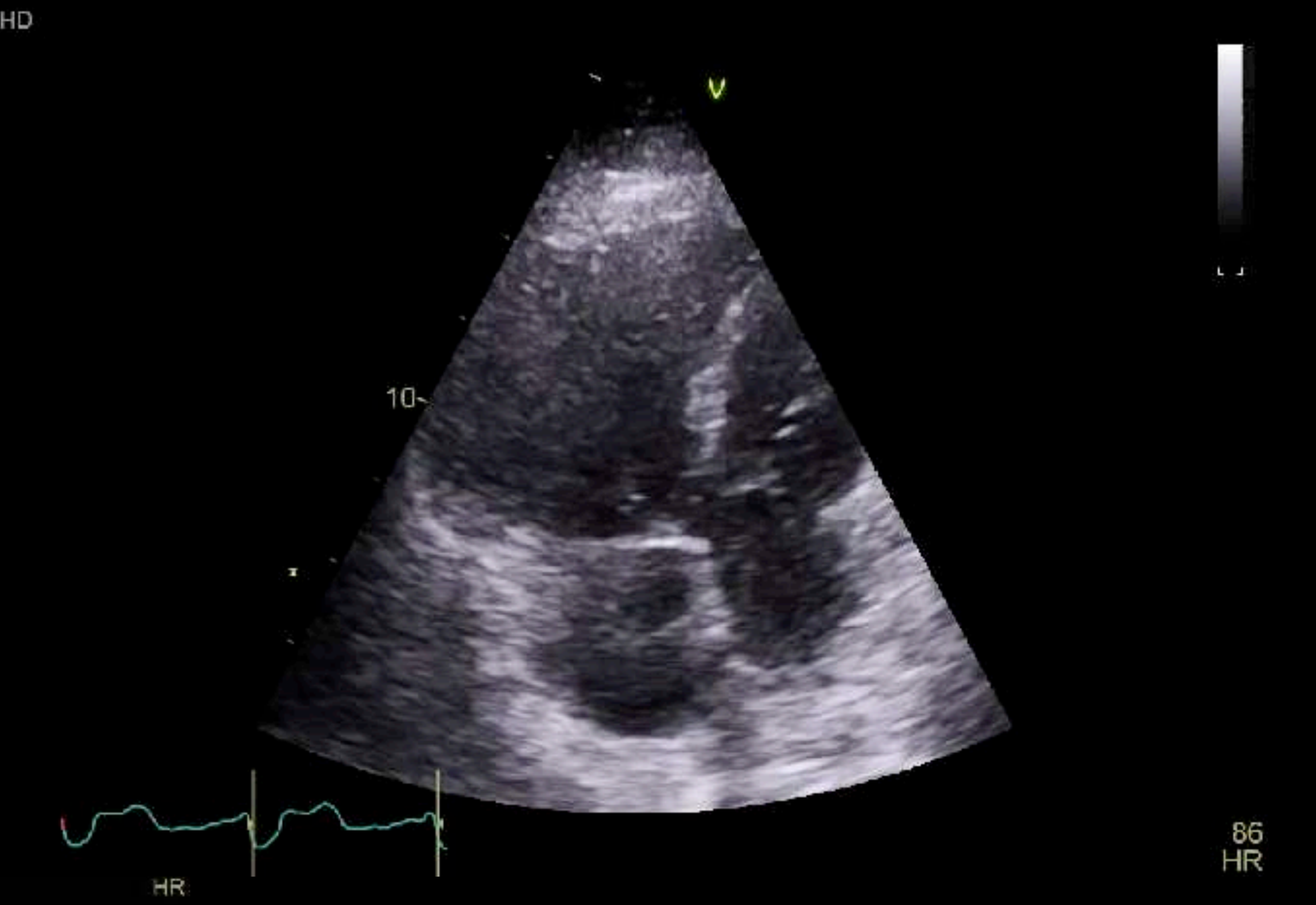
RV size =

Severely dilated
Pressure & <u>volume</u> overload









74yoM PC = Unwell SOB++. PMH: HFPEF, pulmonary hypertension, ex-smoker
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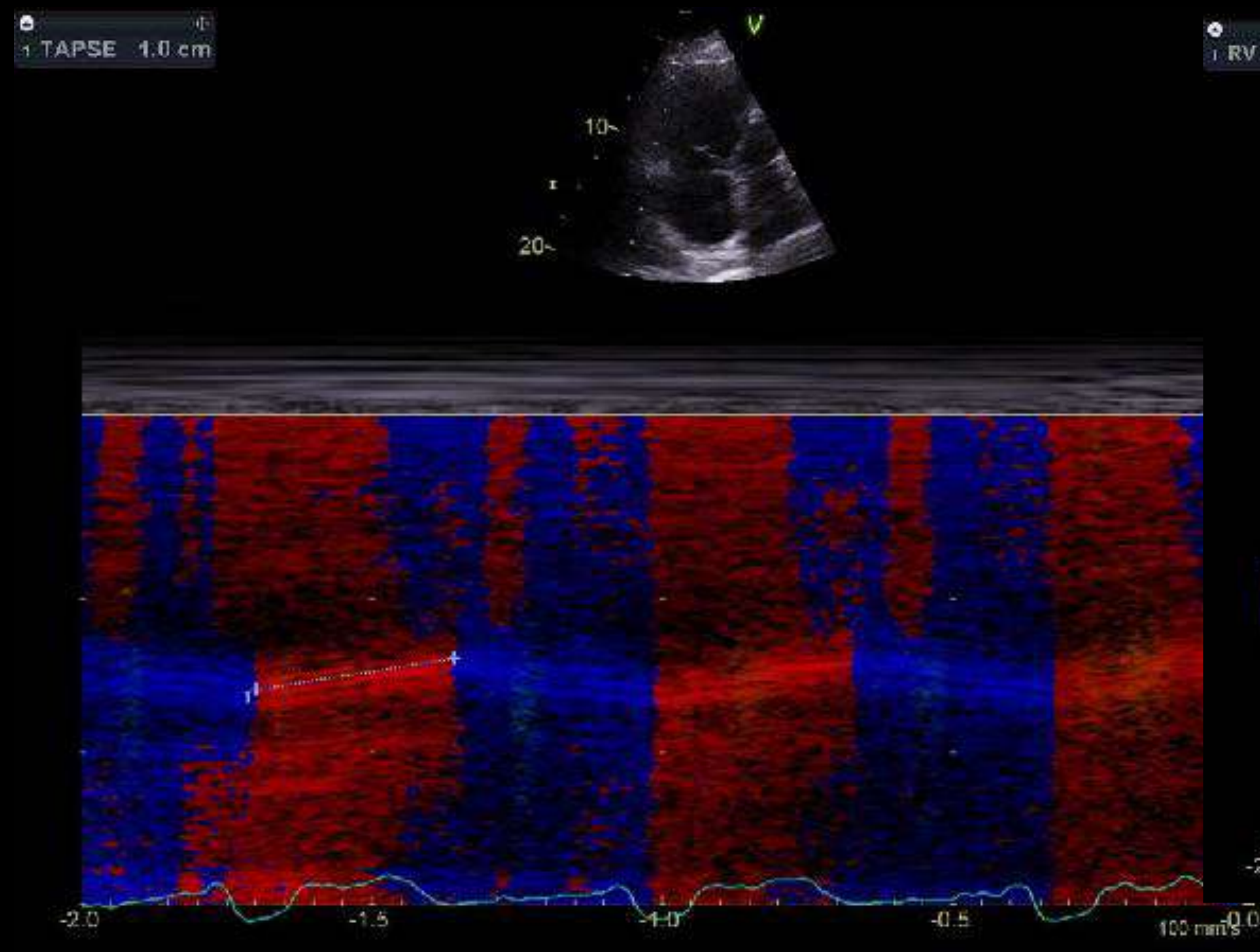
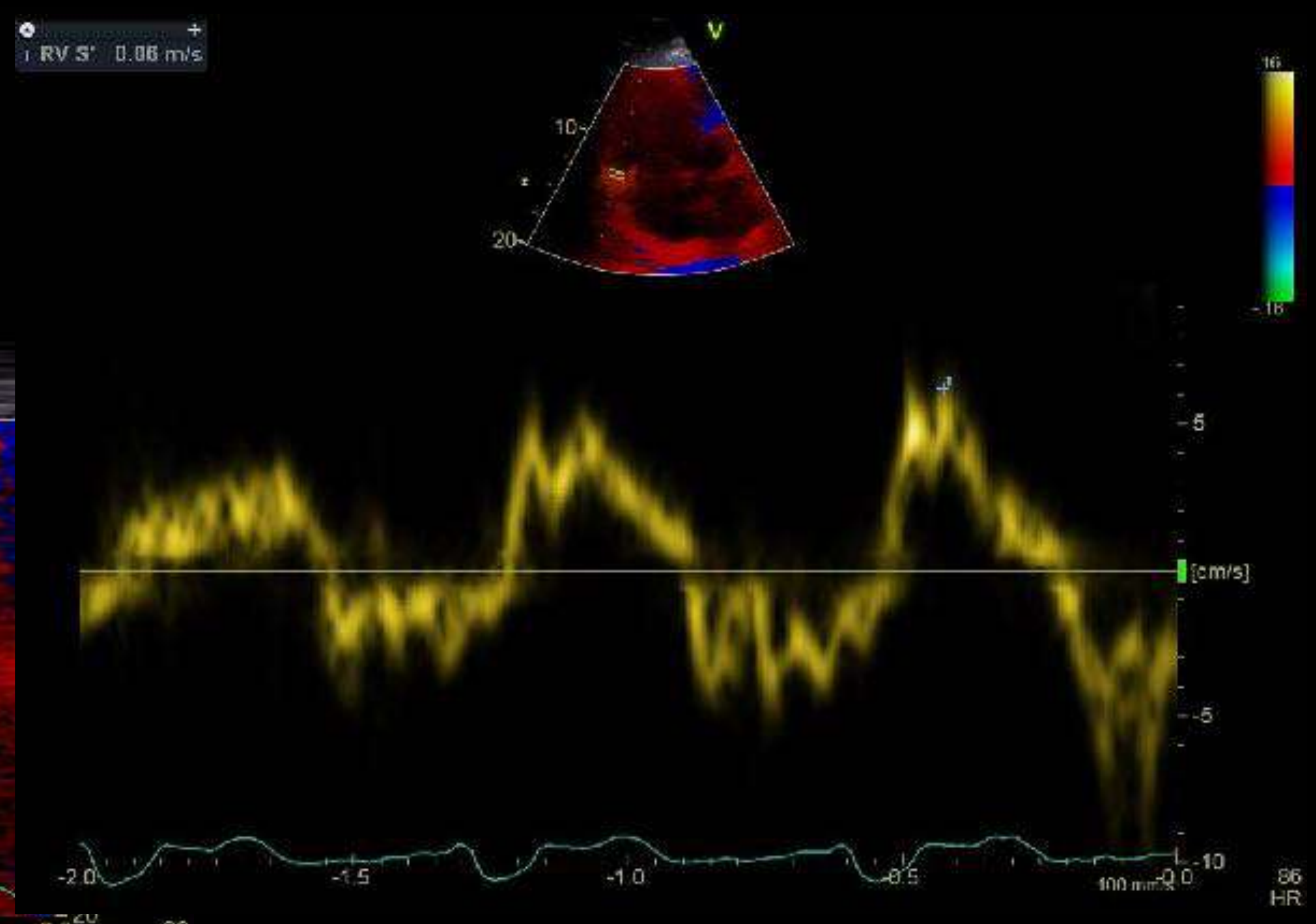
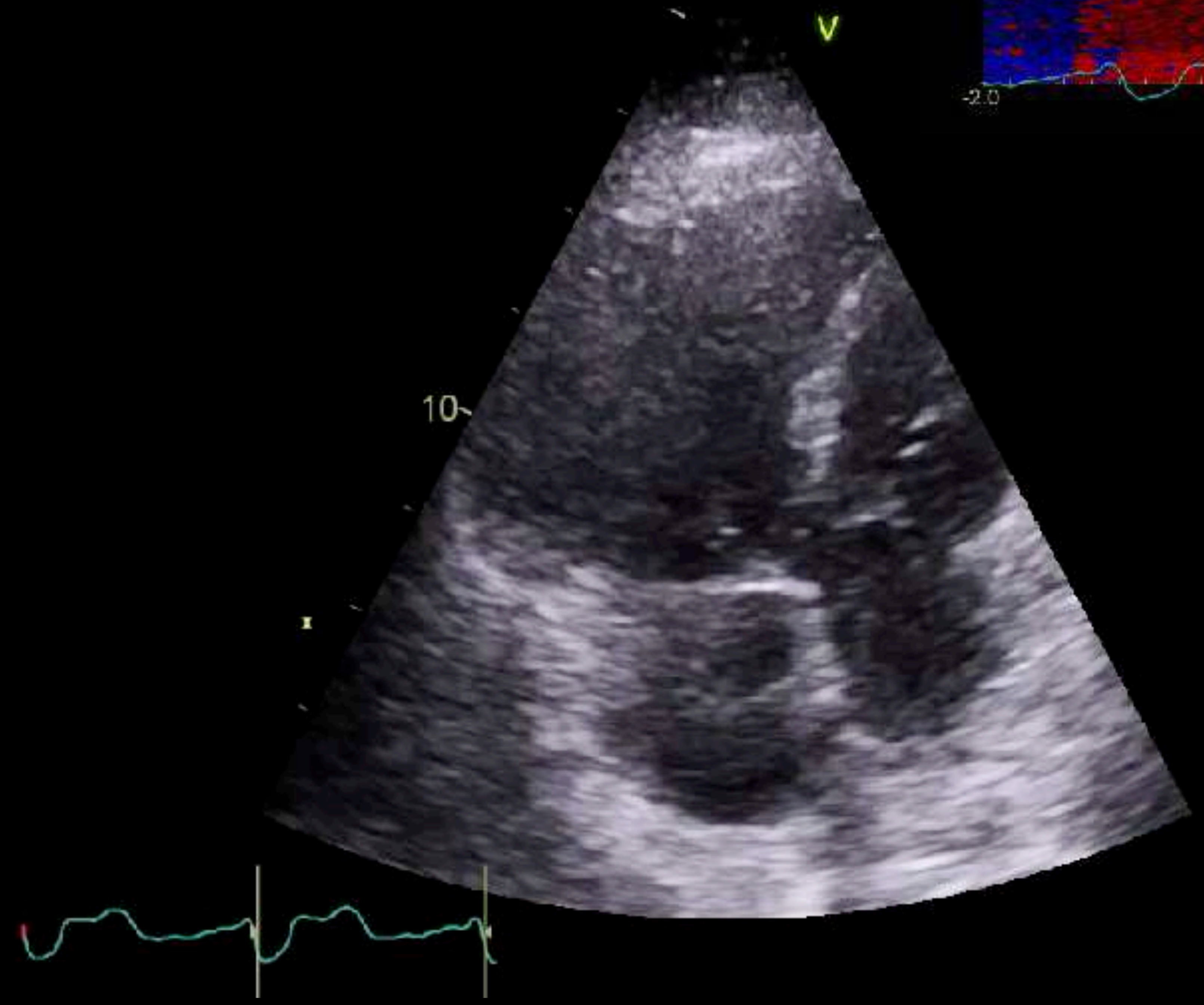
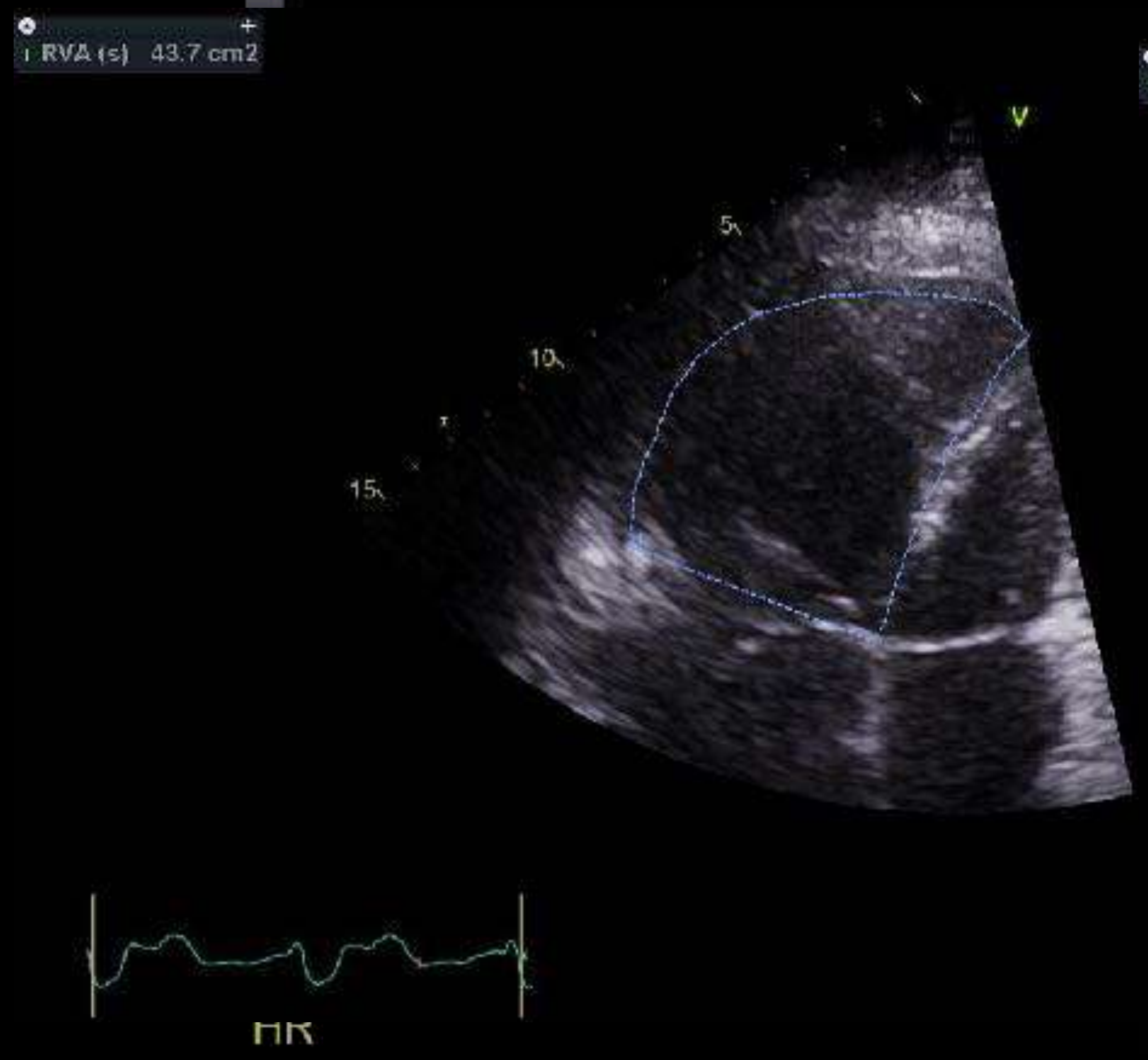
RV function =

Severely reduced

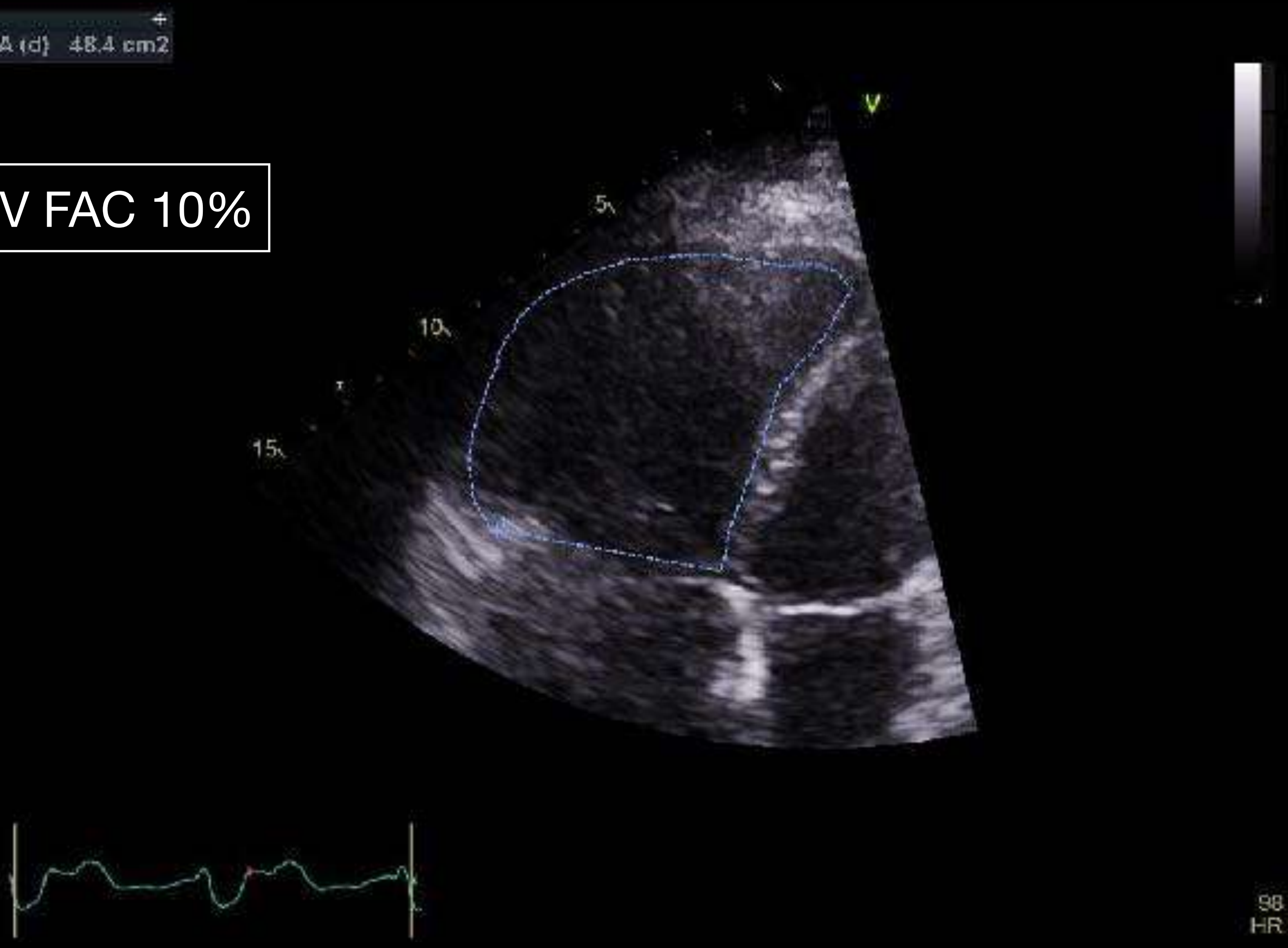








RV FAC 10%



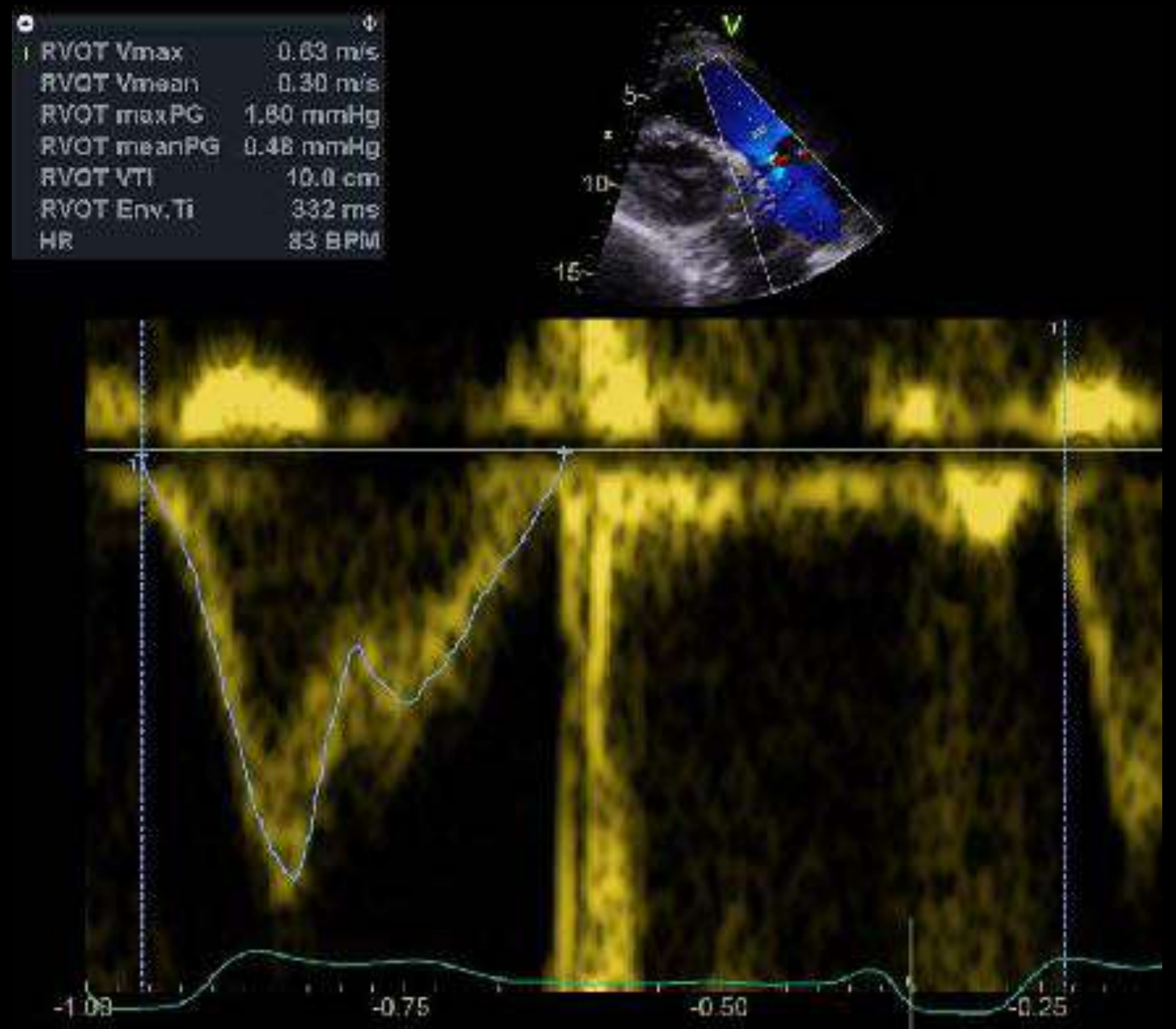
74yoM PC = Unwell SOB++. PMH: HFPEF, pulmonary hypertension, ex-smoker
Imp = Septic shock ? Pneumonia
Issues: AKI with oliguria. Lactate 4. Mild LFT derangement.

Pulmonary pressures =

>60mmHg
(+ RV down,
likely underestimated)

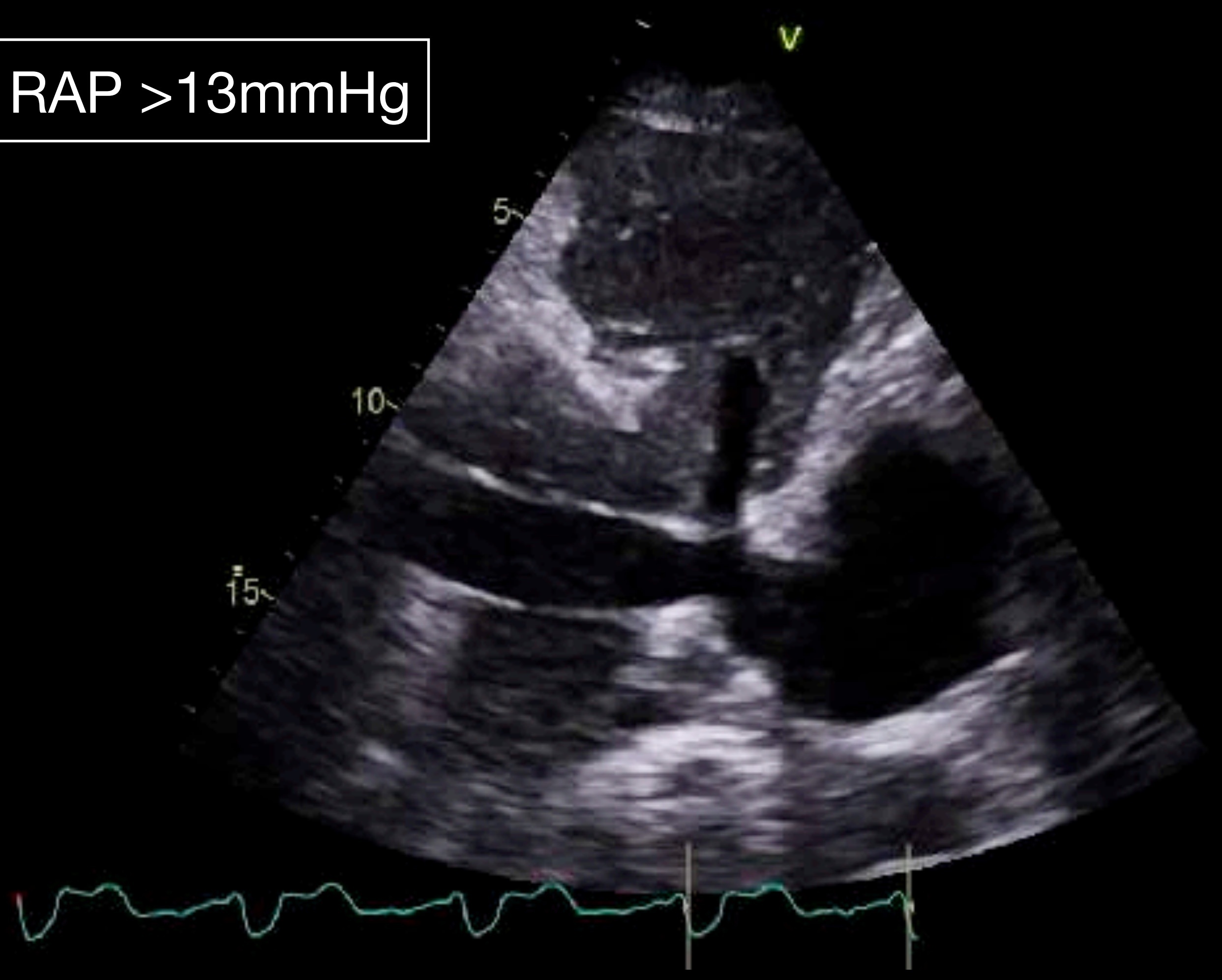
High likelihood severe
Pulmonary hypertension

Pre-cap contribution++

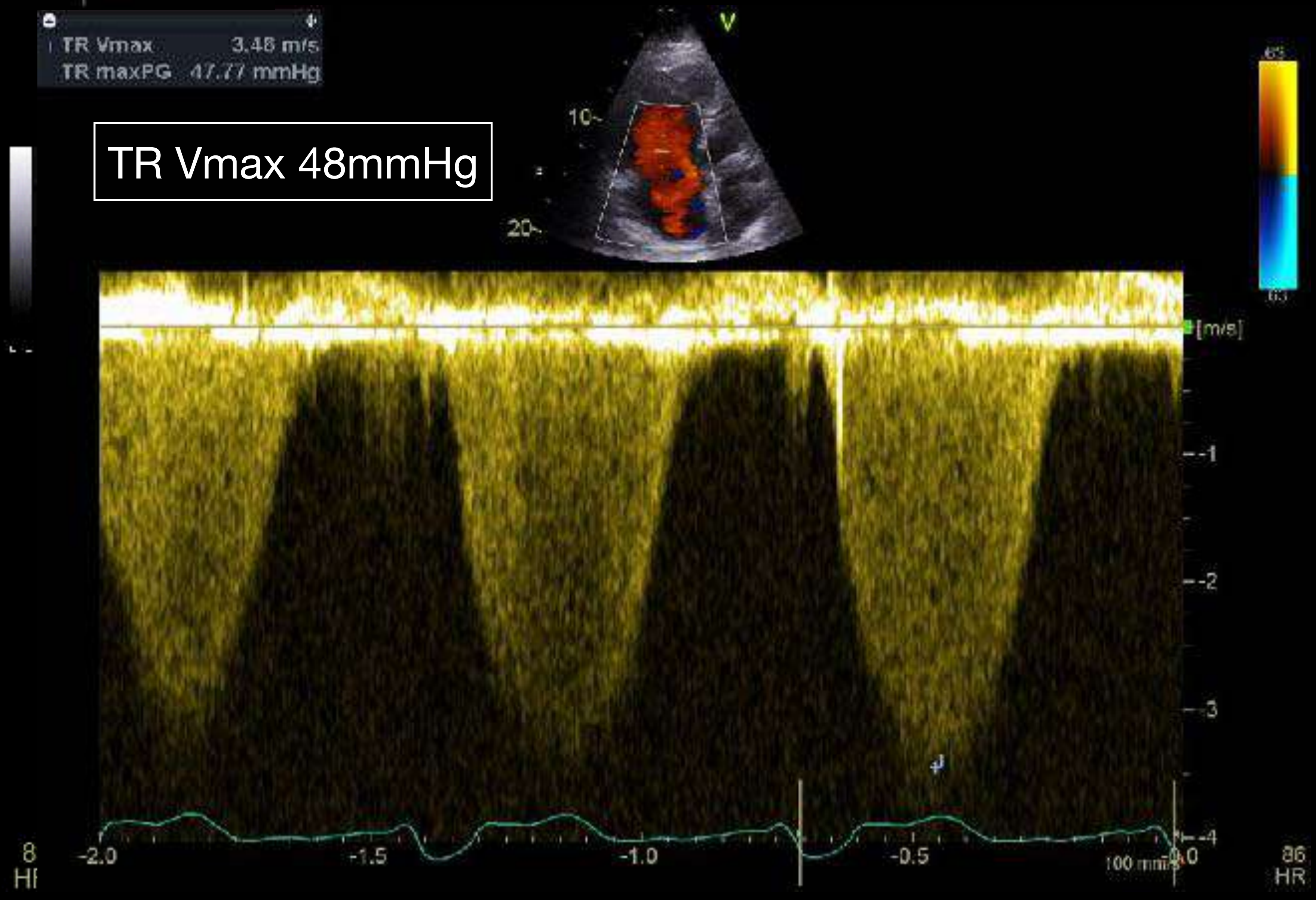


HD

RAP >13mmHg



TR Vmax 48mmHg



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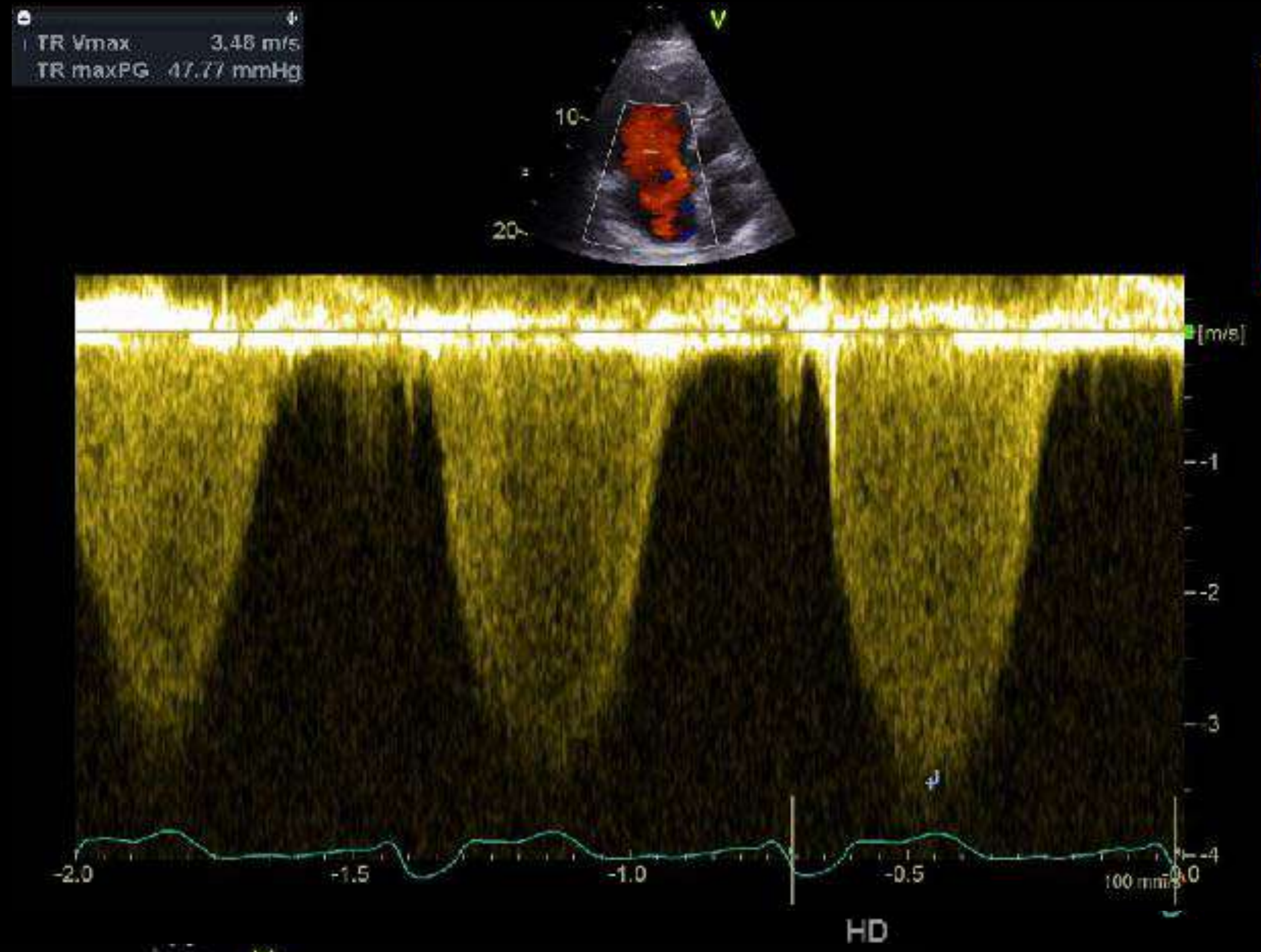
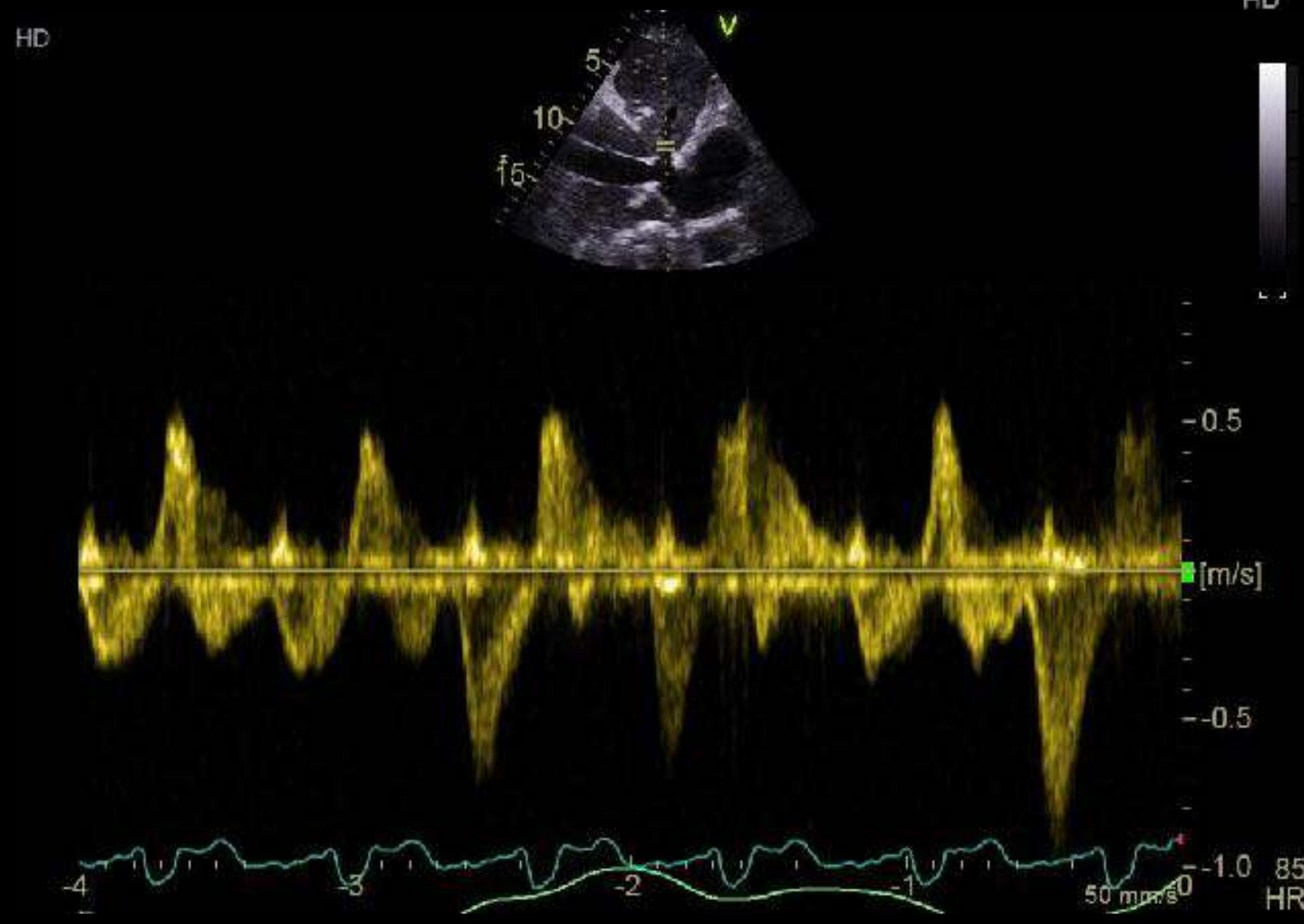
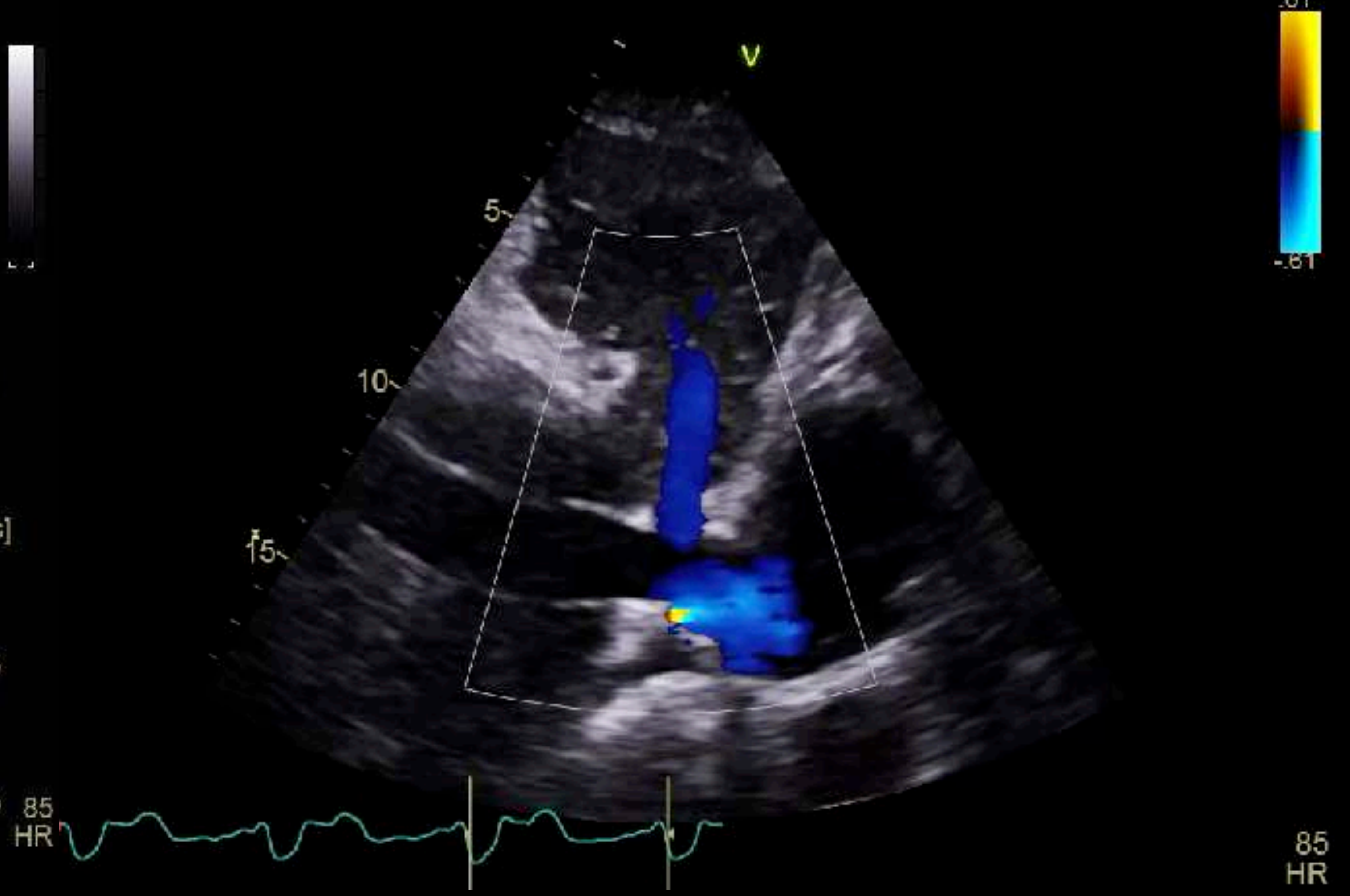
TR severity =

Severe







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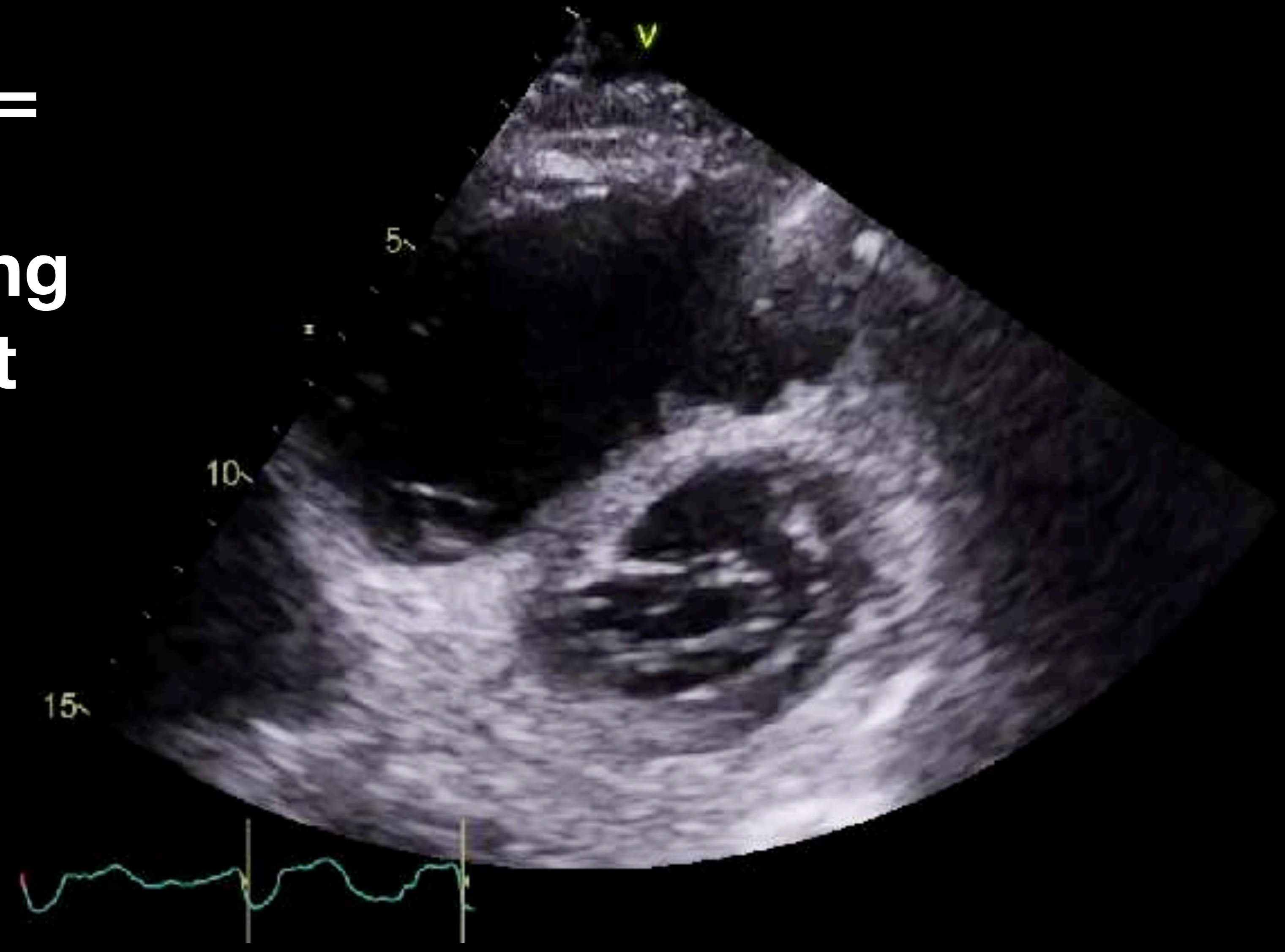
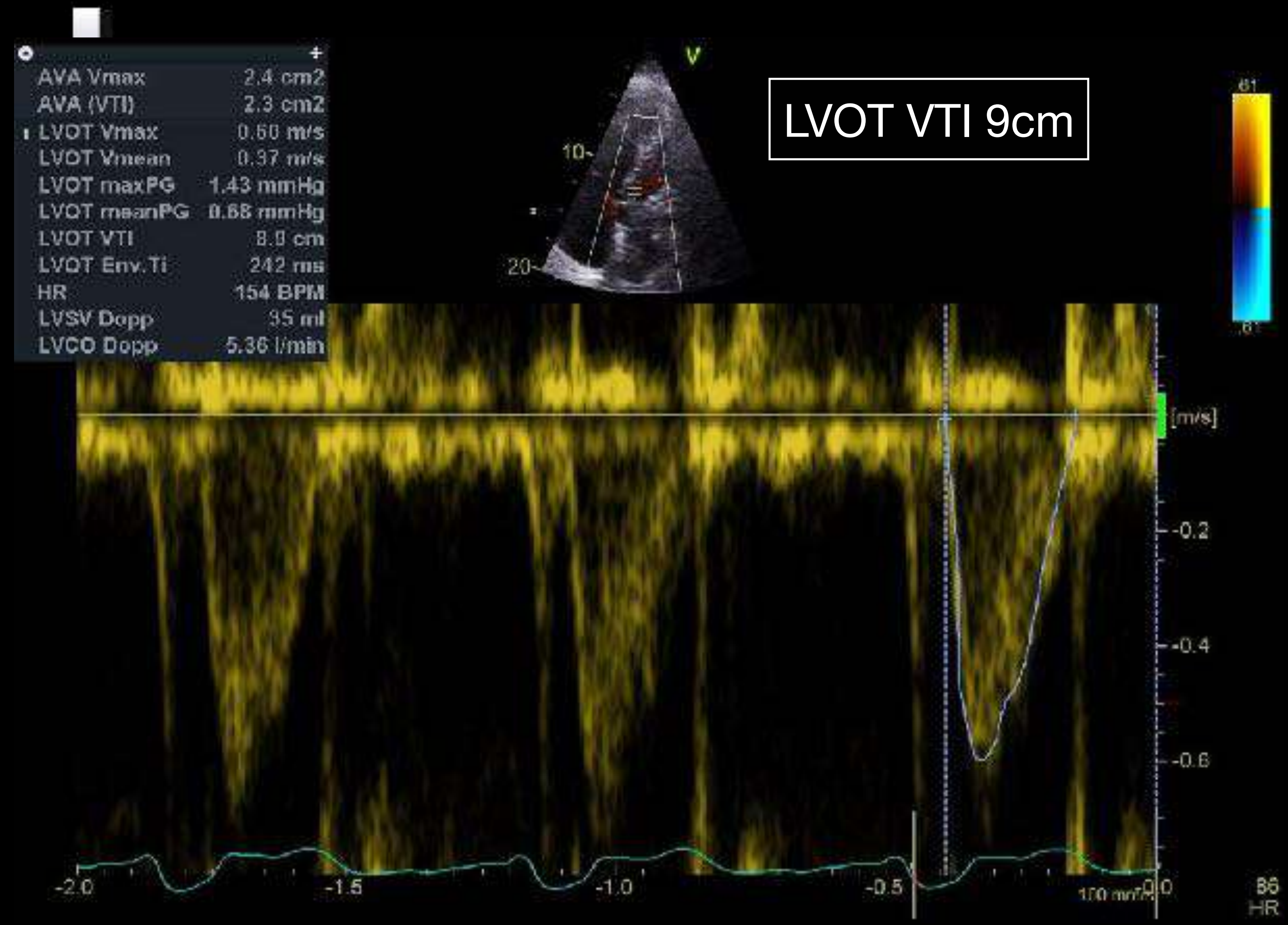
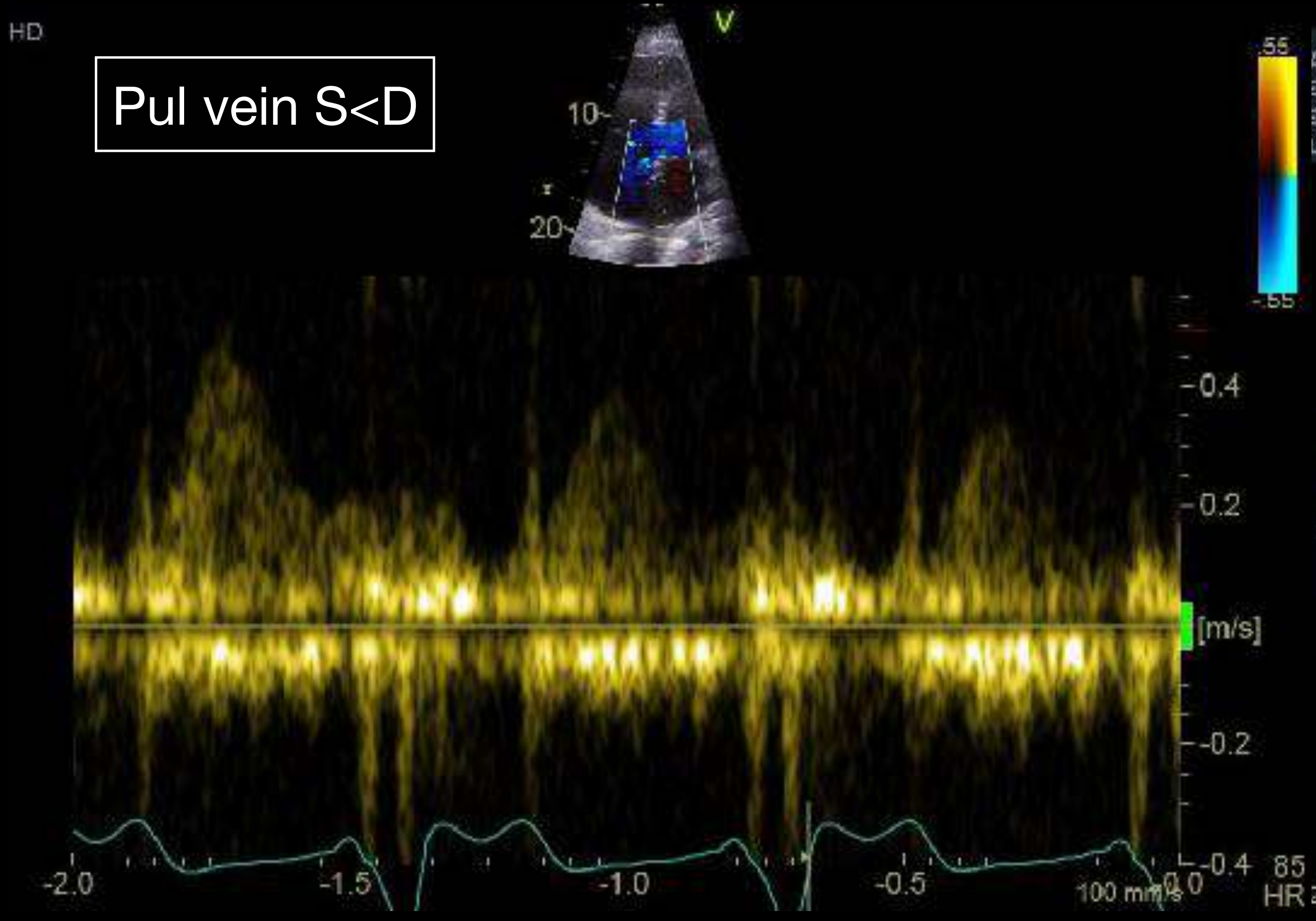
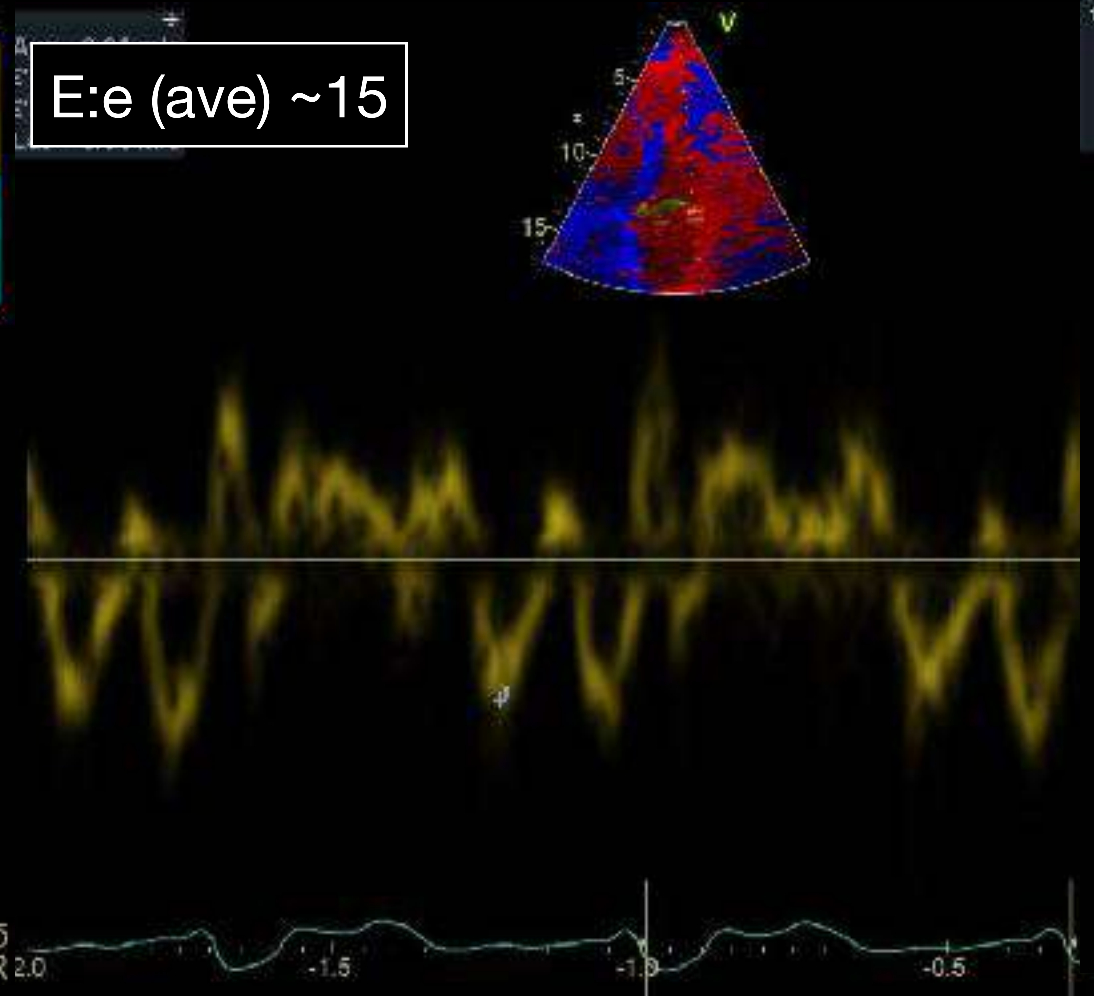
Effect on LV =

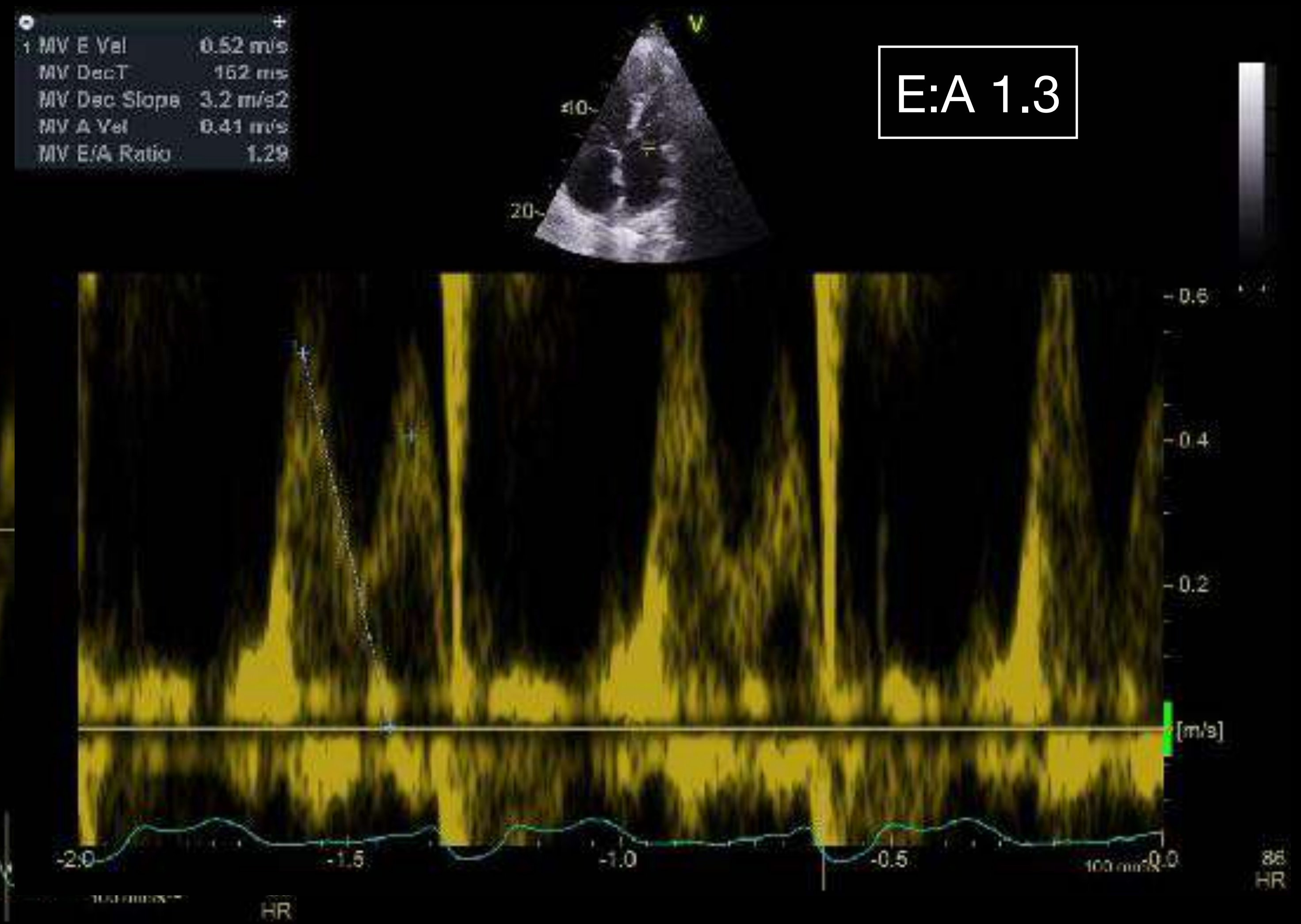
Impaired LV filling
Poor LV output







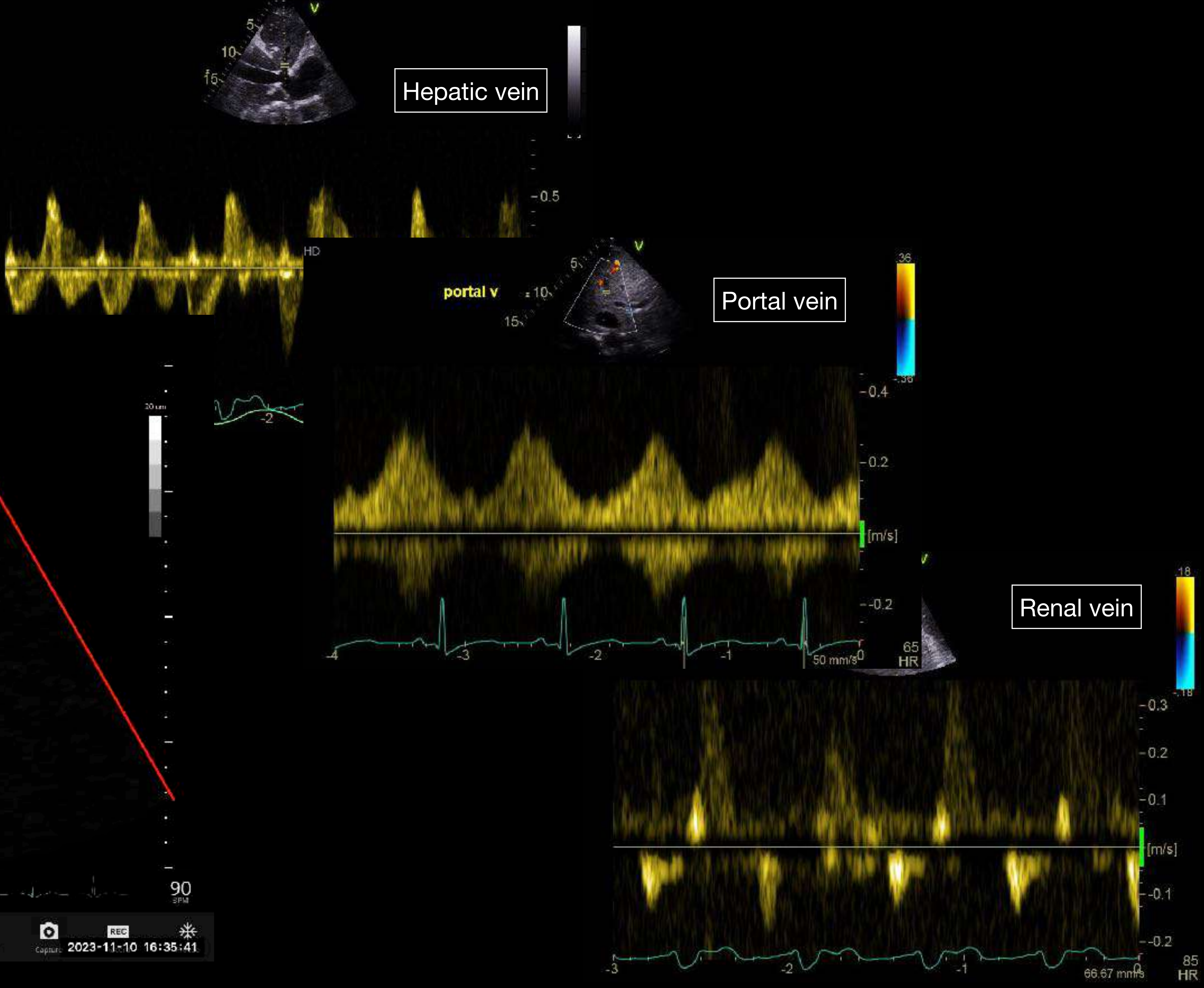


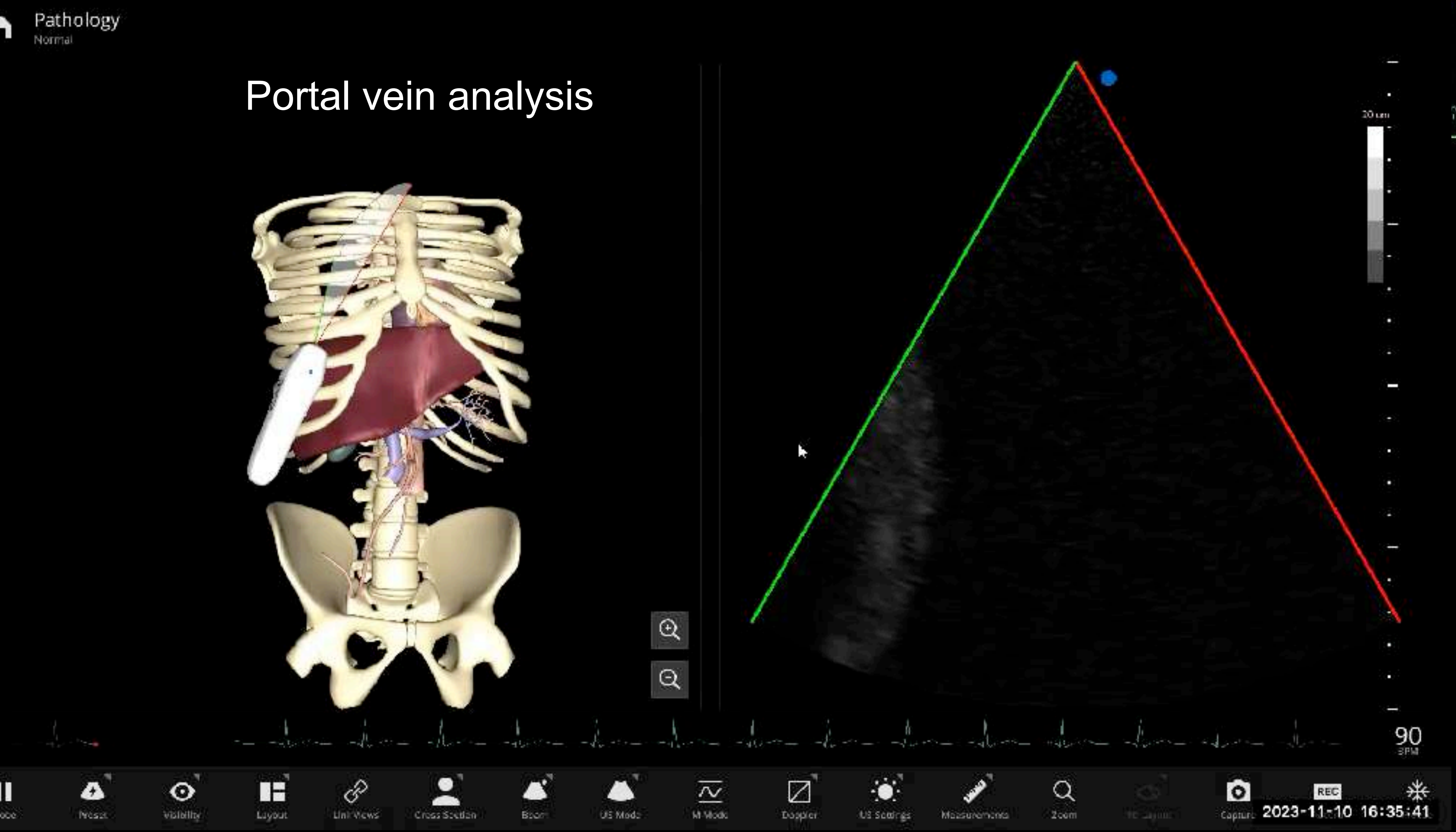


74yoM PC = Unwell SOB++. PMH: HFPEF, pulmonary hypertension, ex-smoker
Imp = Septic shock ? Pneumonia
Issues: AKI with oliguria. Lactate 4. Mild LFT derangement.

VExUS =

Severe congestion





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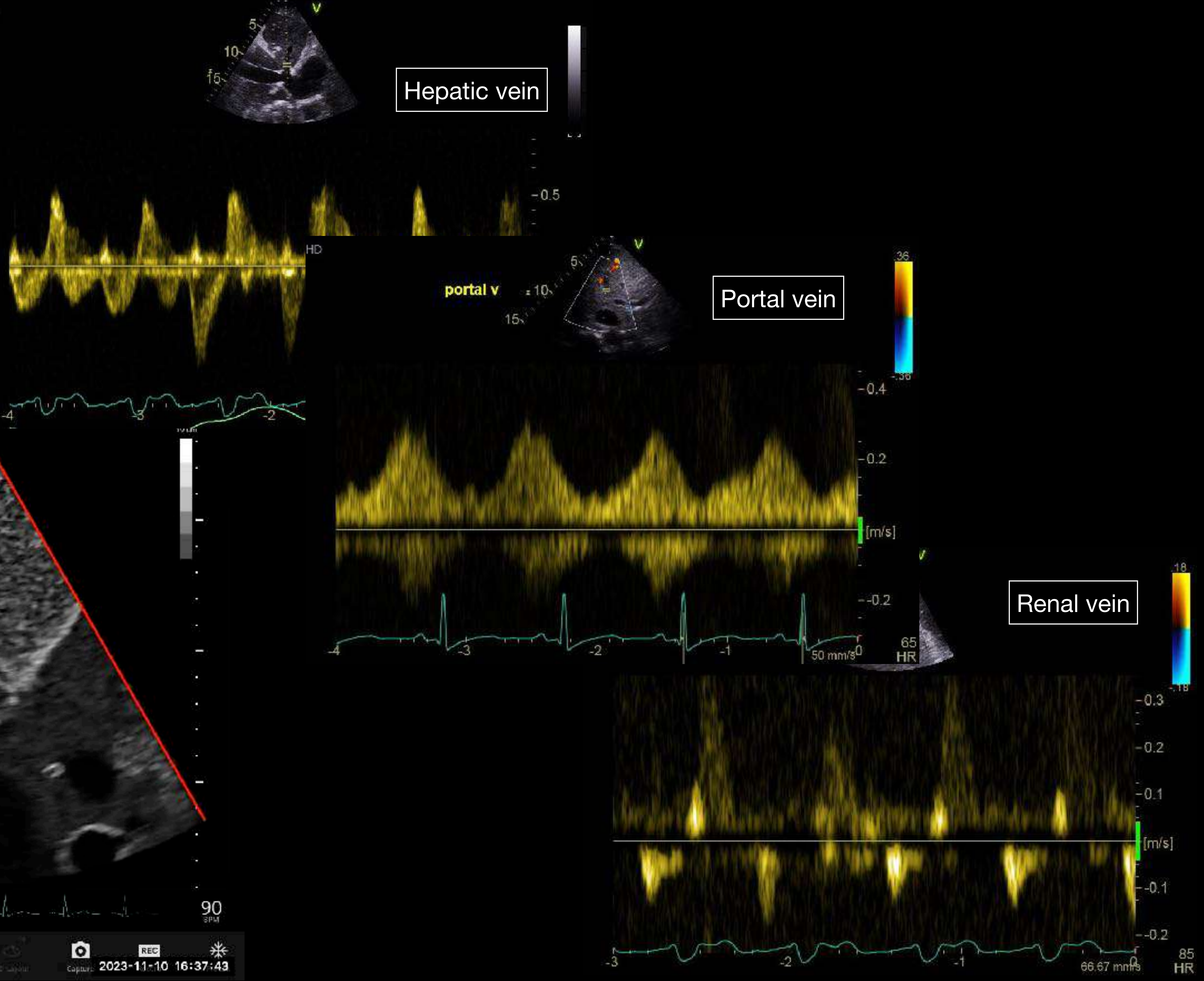
VExUS =

Severe congestion

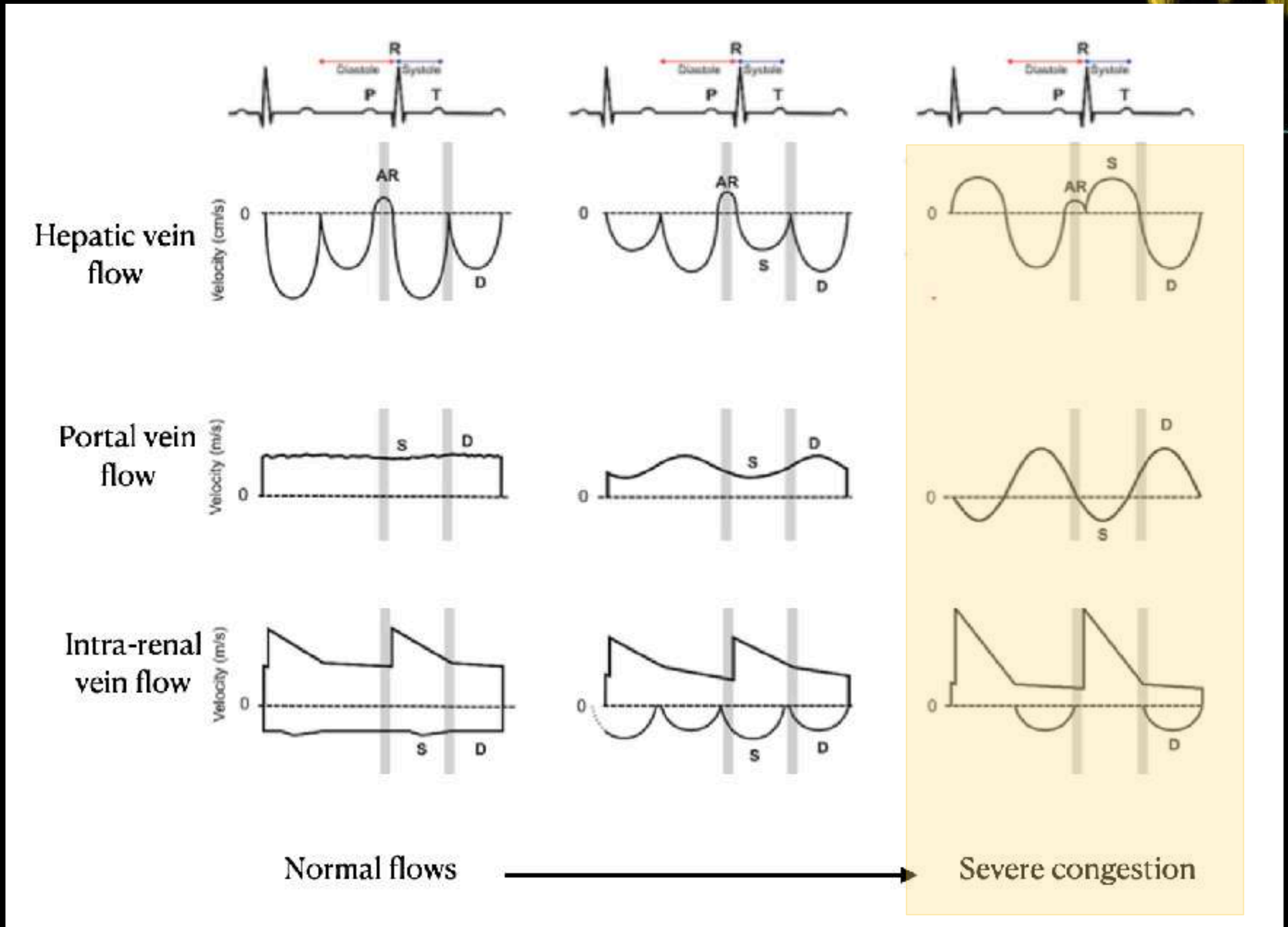


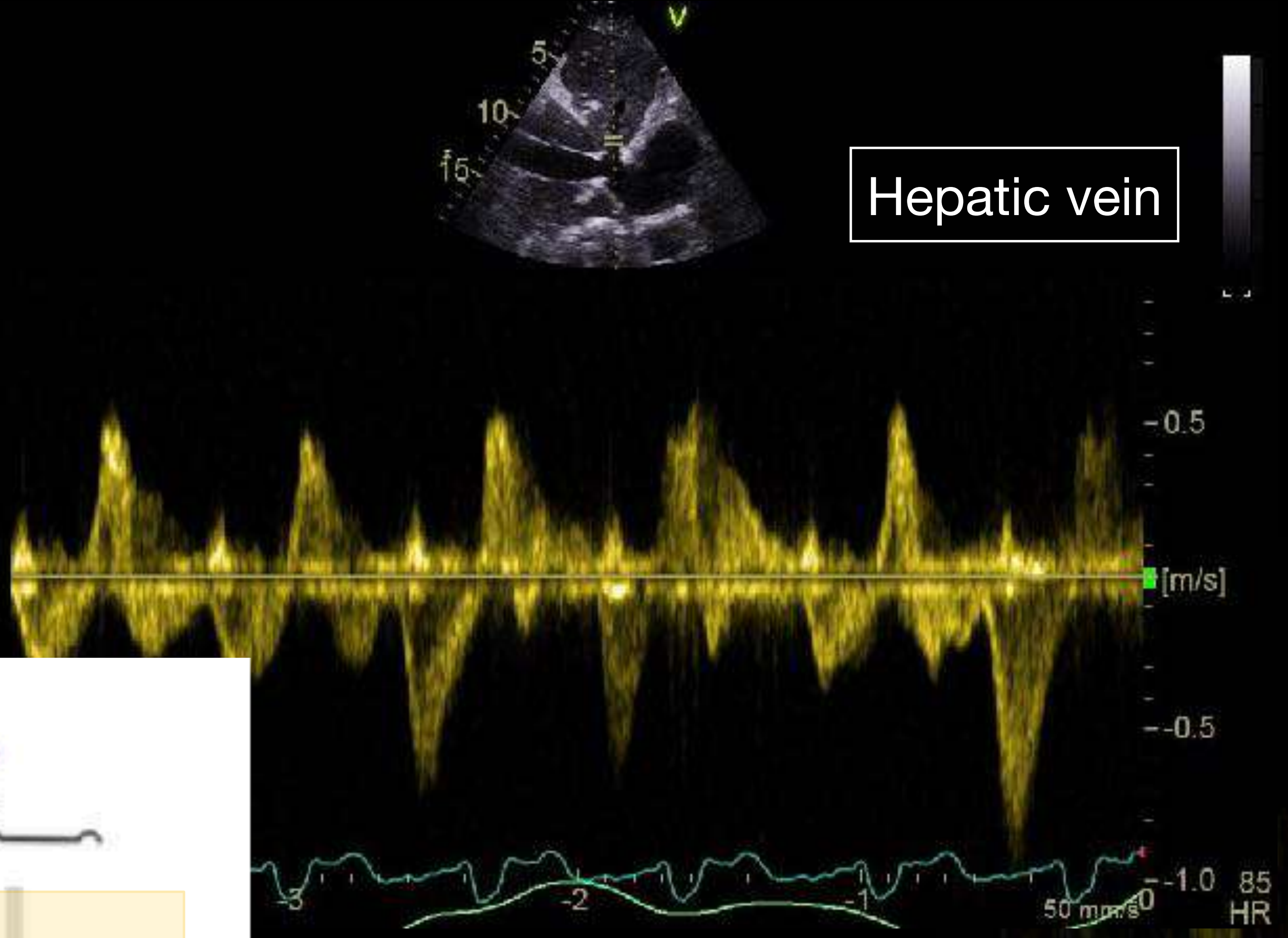
Renal vein analysis

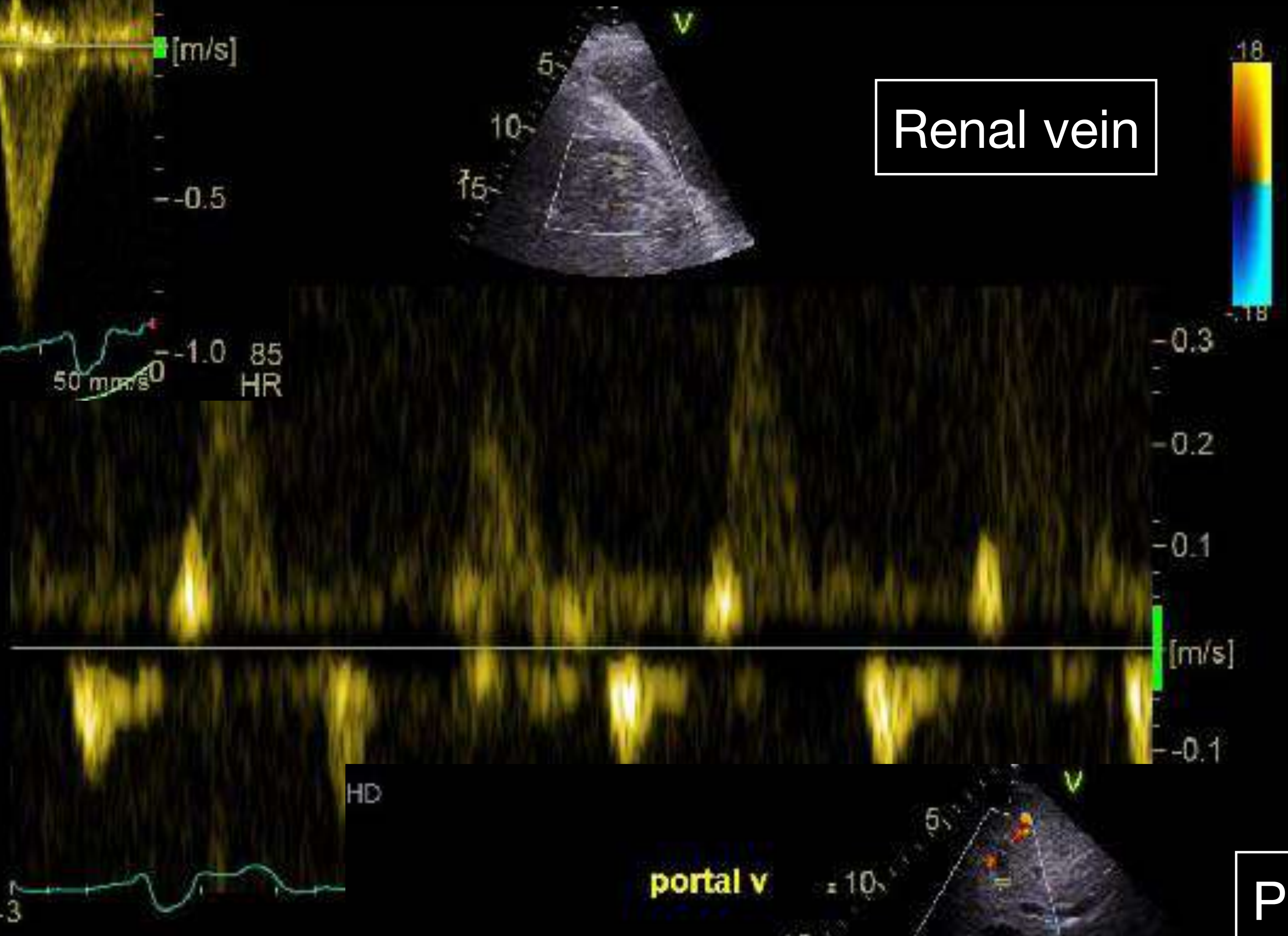
74yoM PC = Unwell SOB++. PMH: HFPEF, pulmonary hypertension, ex-smoker
Imp = Septic shock ? Pneumonia
Issues: AKI with oliguria. Lactate 4. Mild LFT derangement.

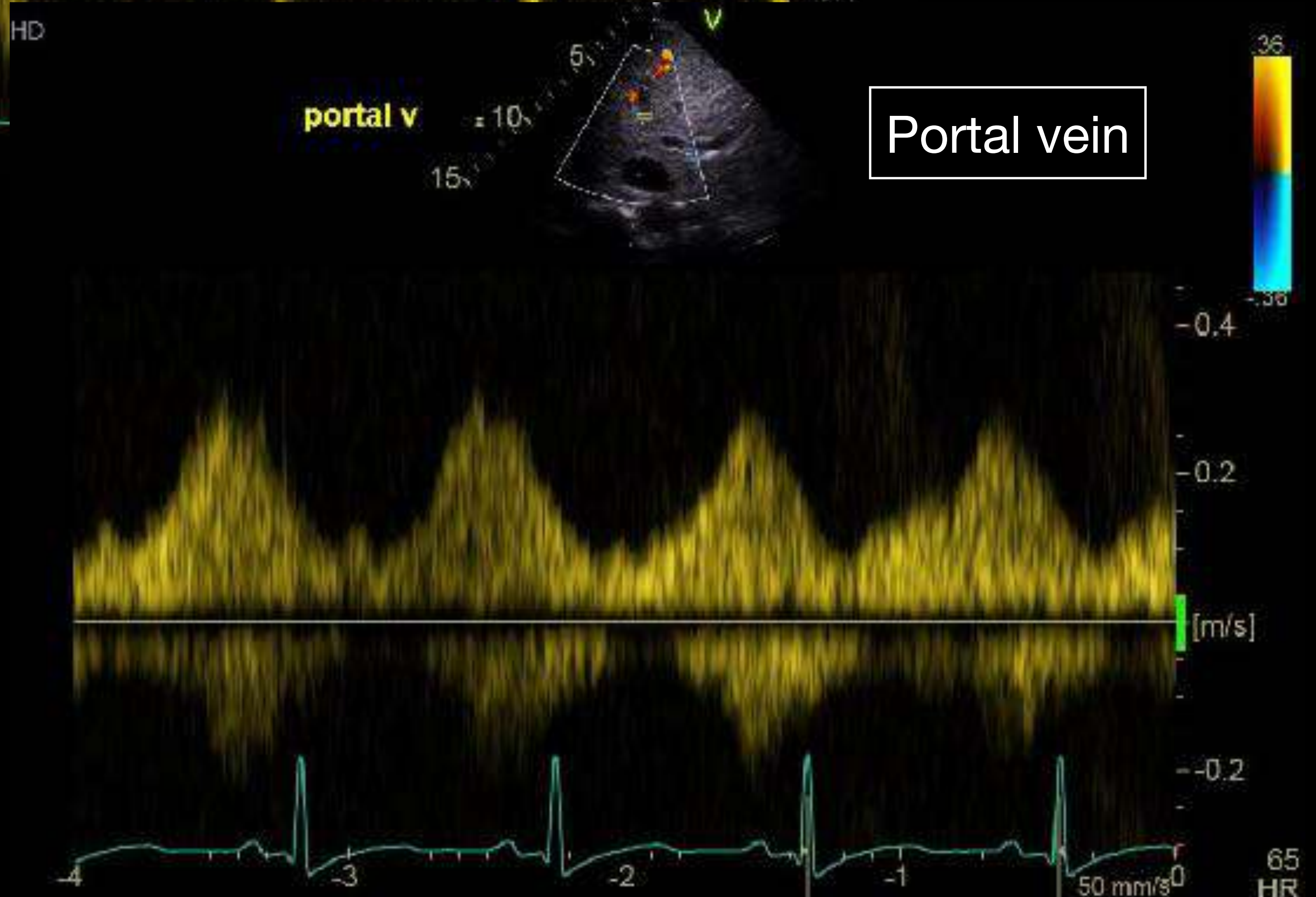
VExUS =

Severe congestion









74yoM PC = Unwell SOB++. PMH: HFPEF, pulmonary hypertension, ex-smoker
Imp = Septic shock ? Pneumonia
Issues: AKI with oliguria. Lactate 4. Mild LFT derangement.

Conclusions

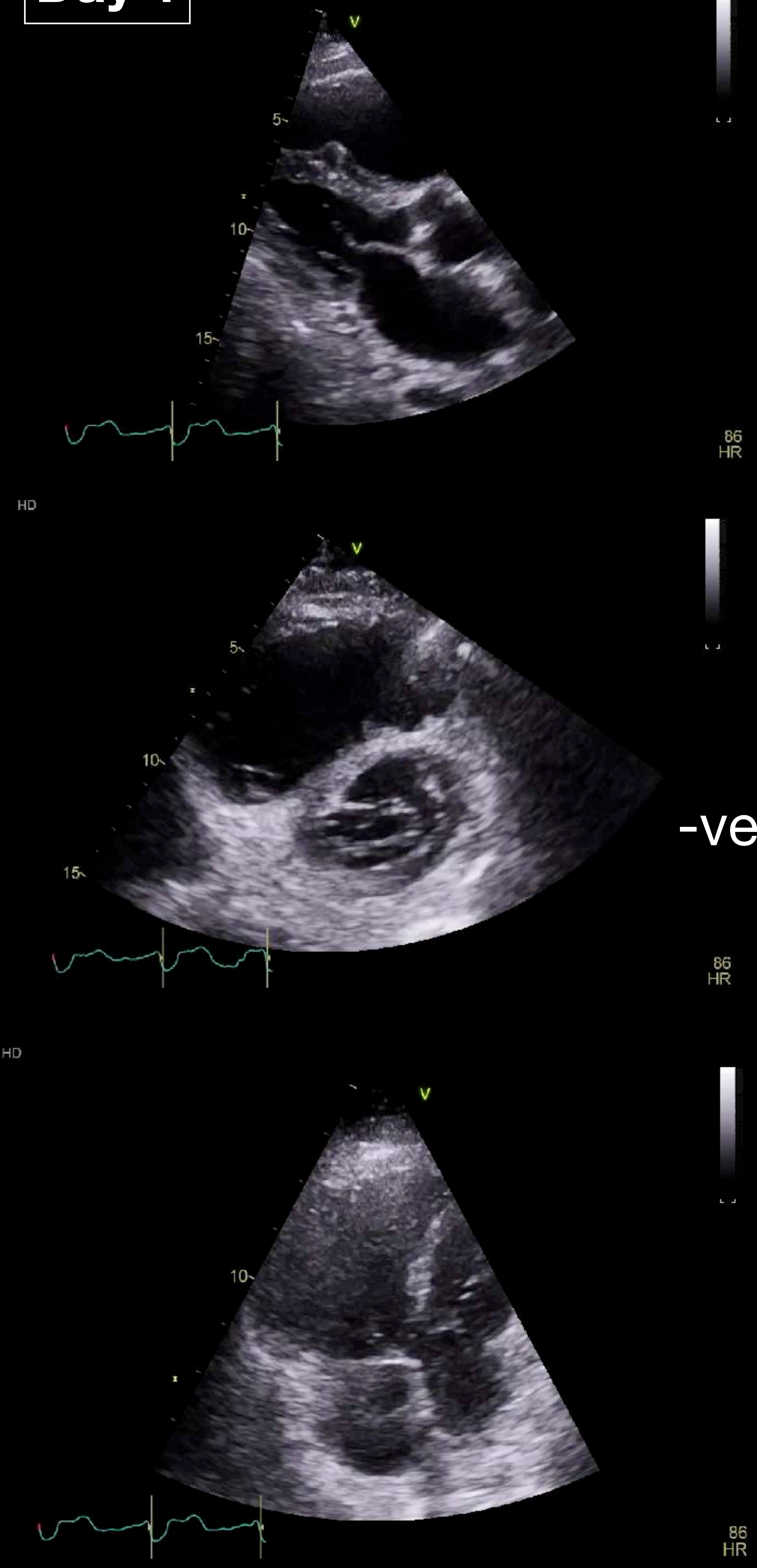
- Clinical and echo features of RV failure and congestion

Imp: Cor Pulmonale

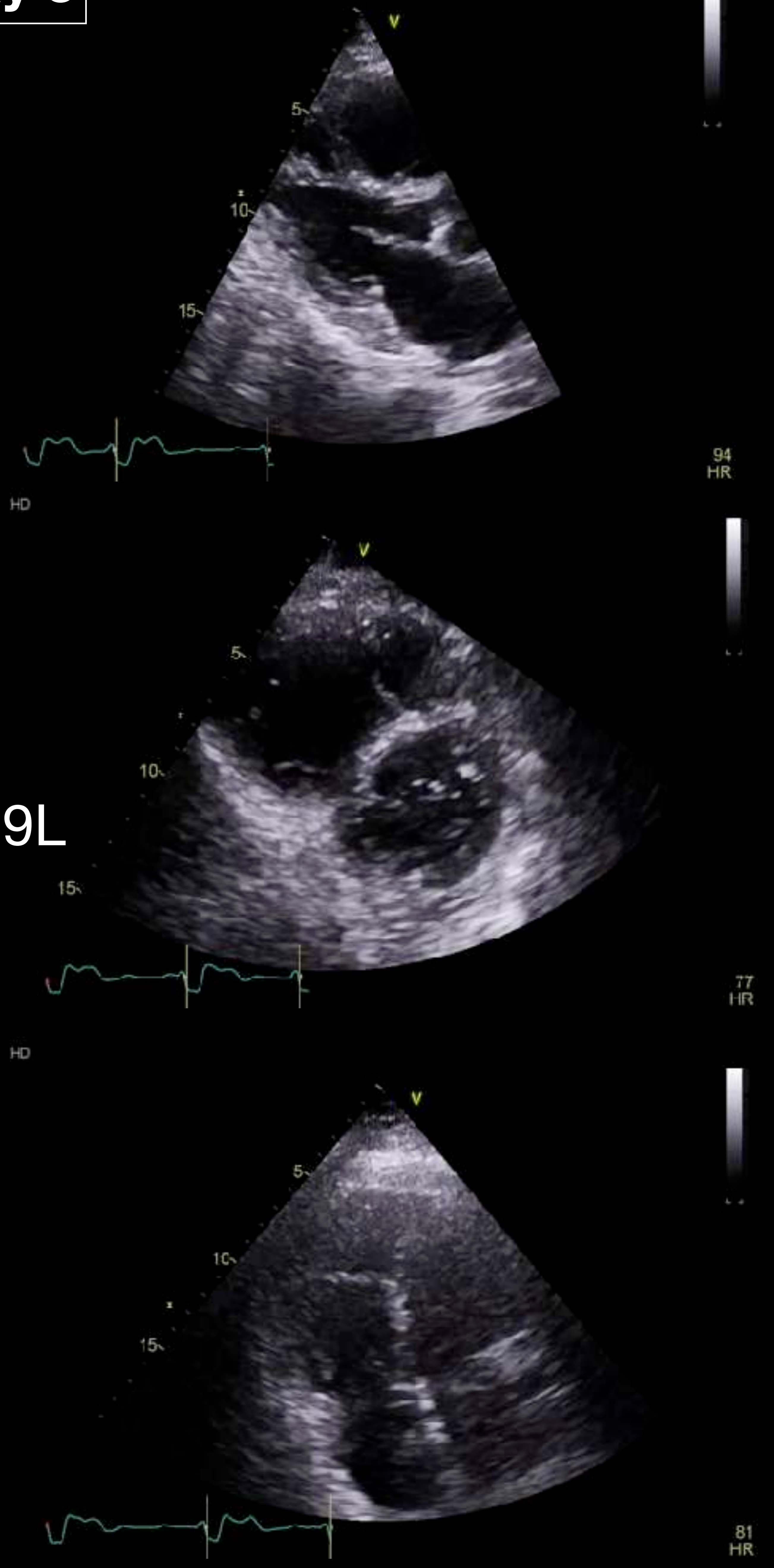
Plan: Aggressive diuresis (Frusemide infusion +/- dialysis)

- Catecholamine choice (ionotrope + vasopressors)
- Communication with patient / family re: risks of intubation etc…

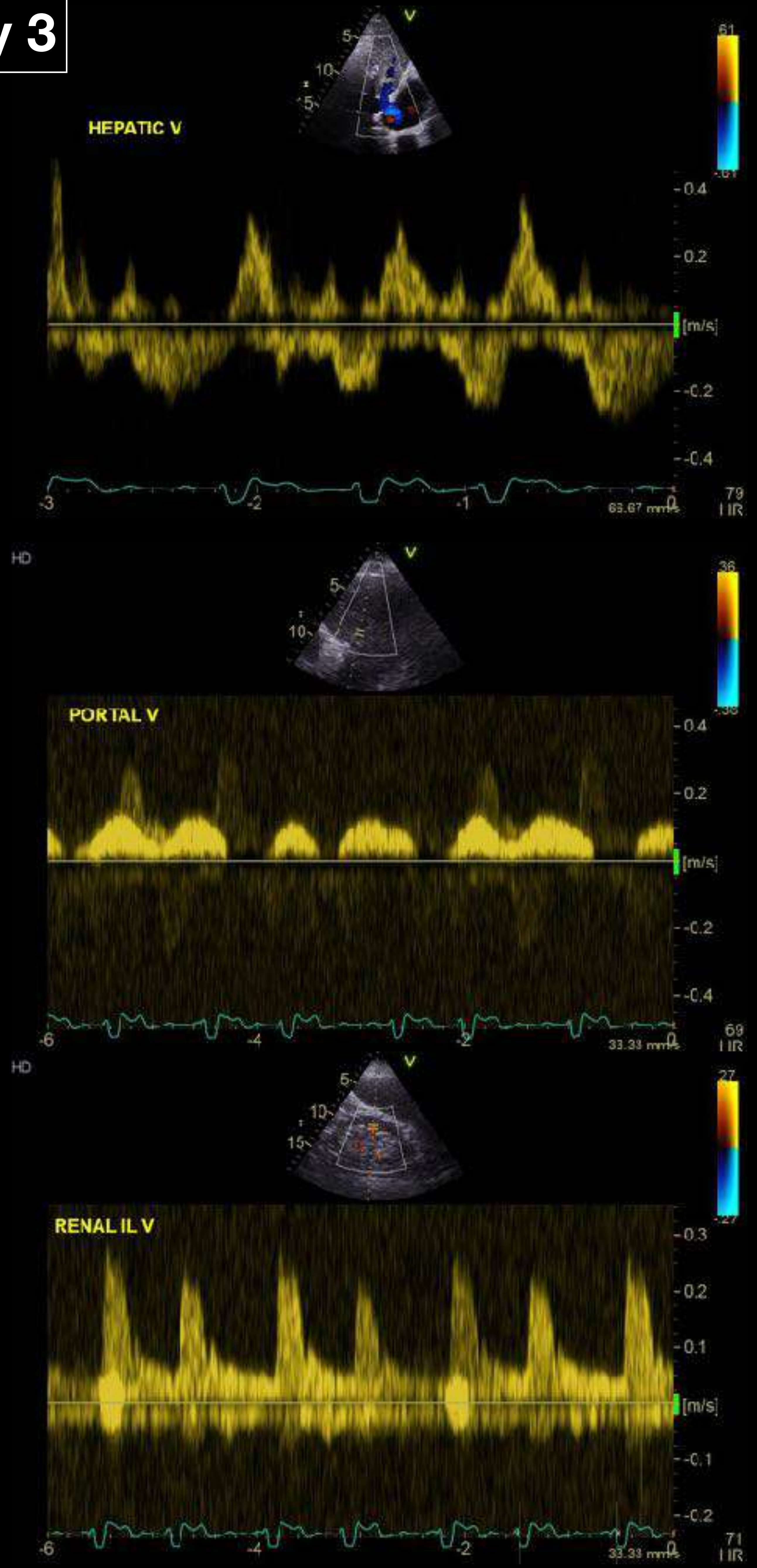
Day 1 **Day 3**

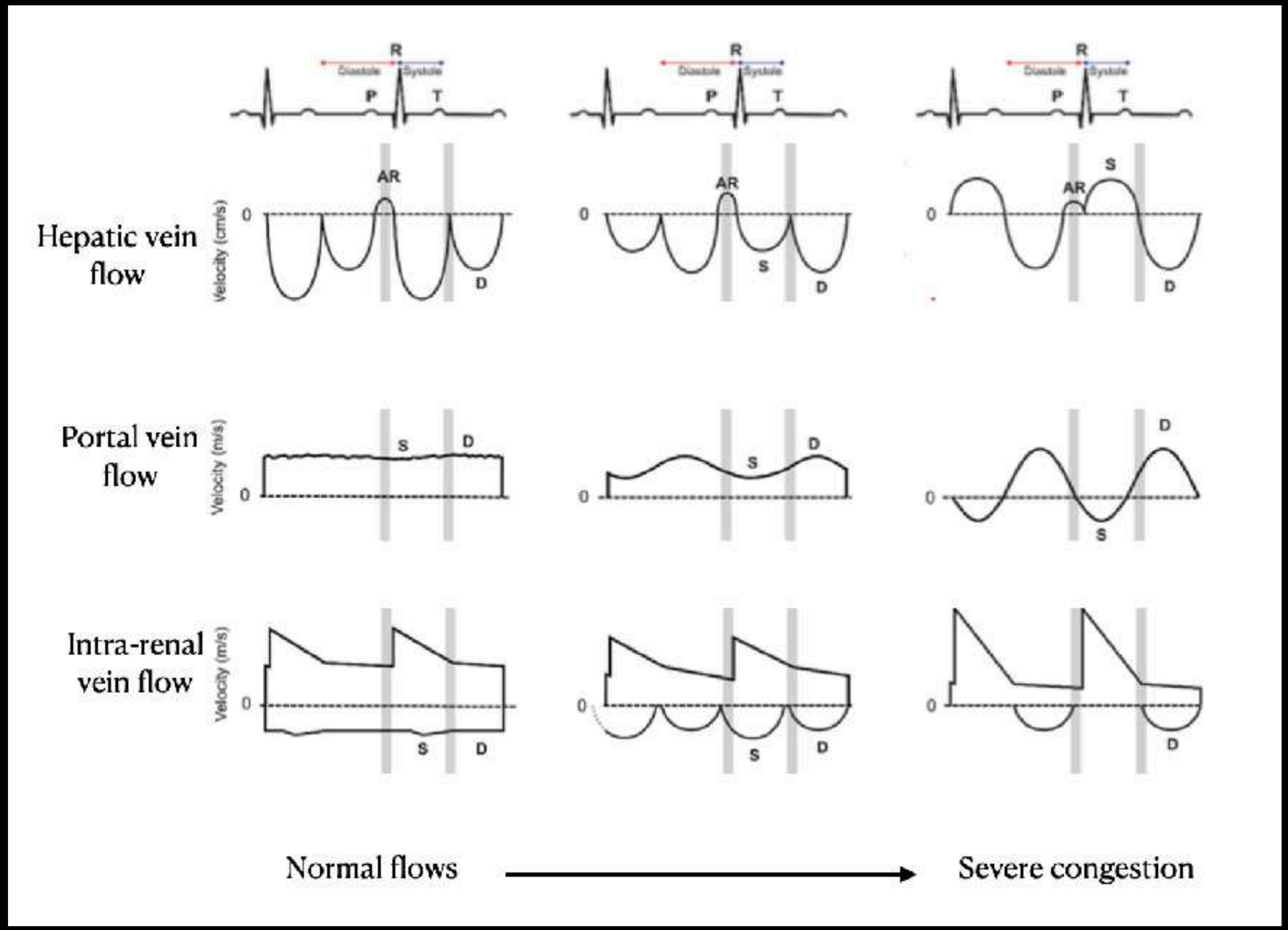


-ve fluid balance >9L



Day 3





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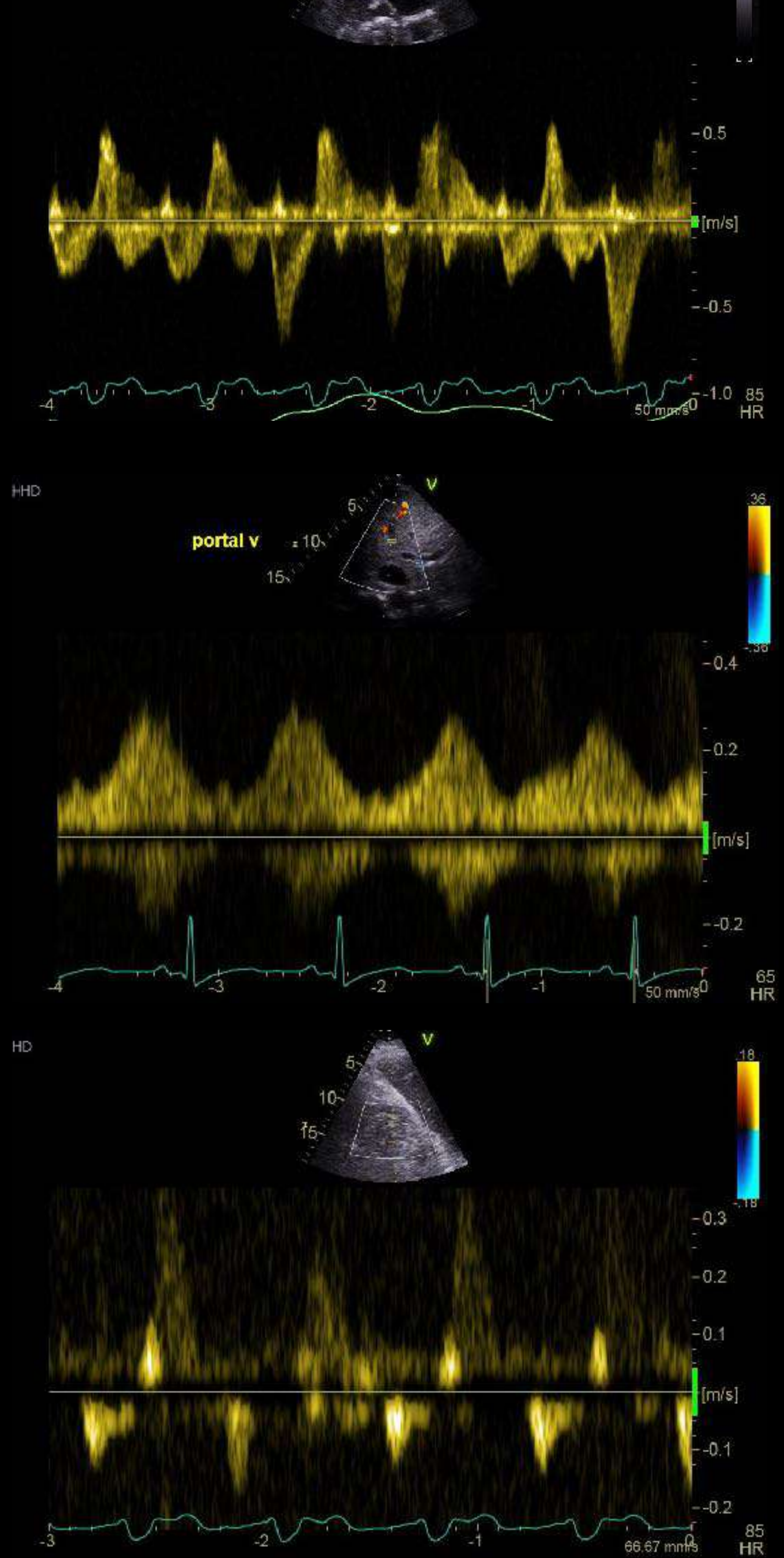
Day 1

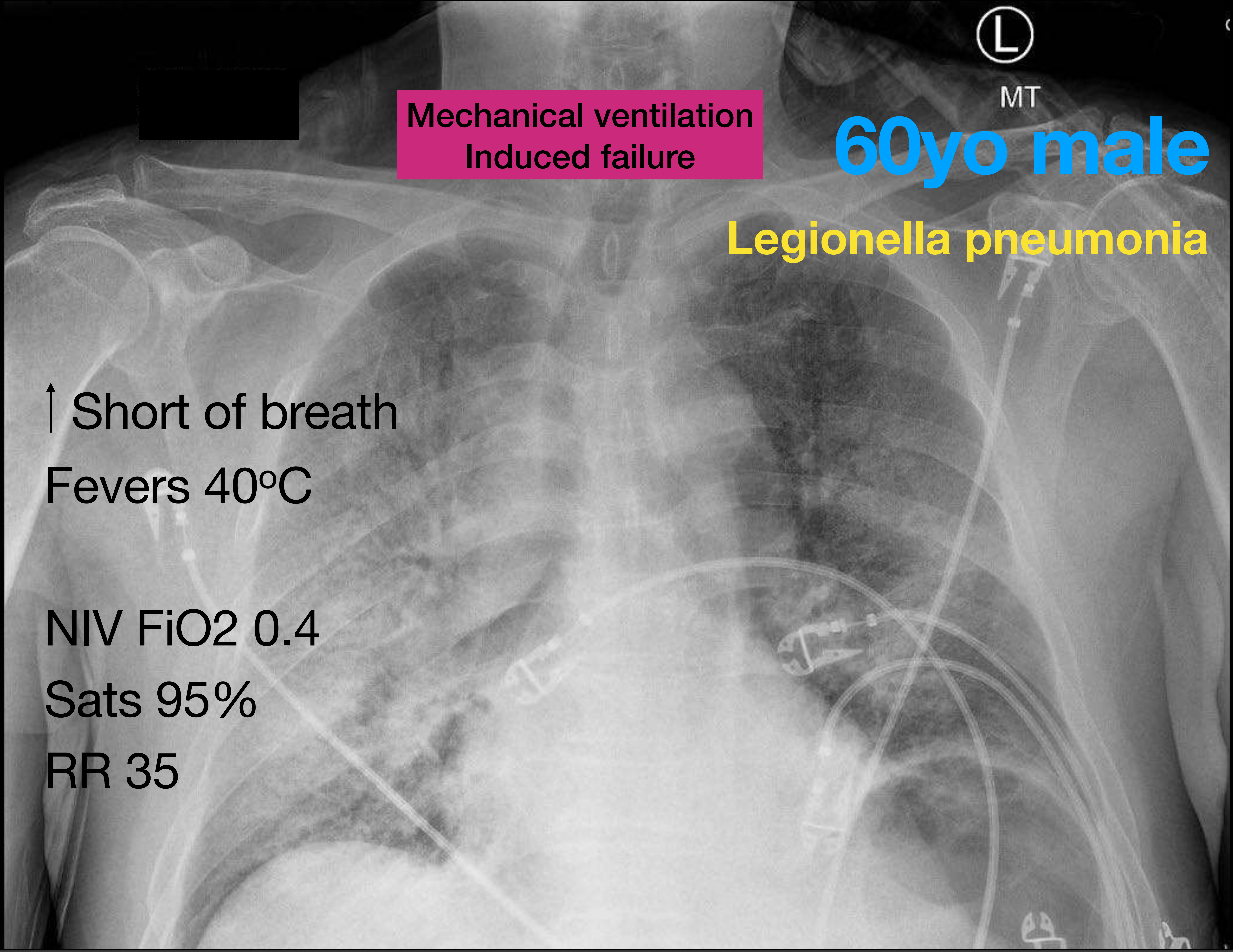


Mechanical ventilation
Induced failure

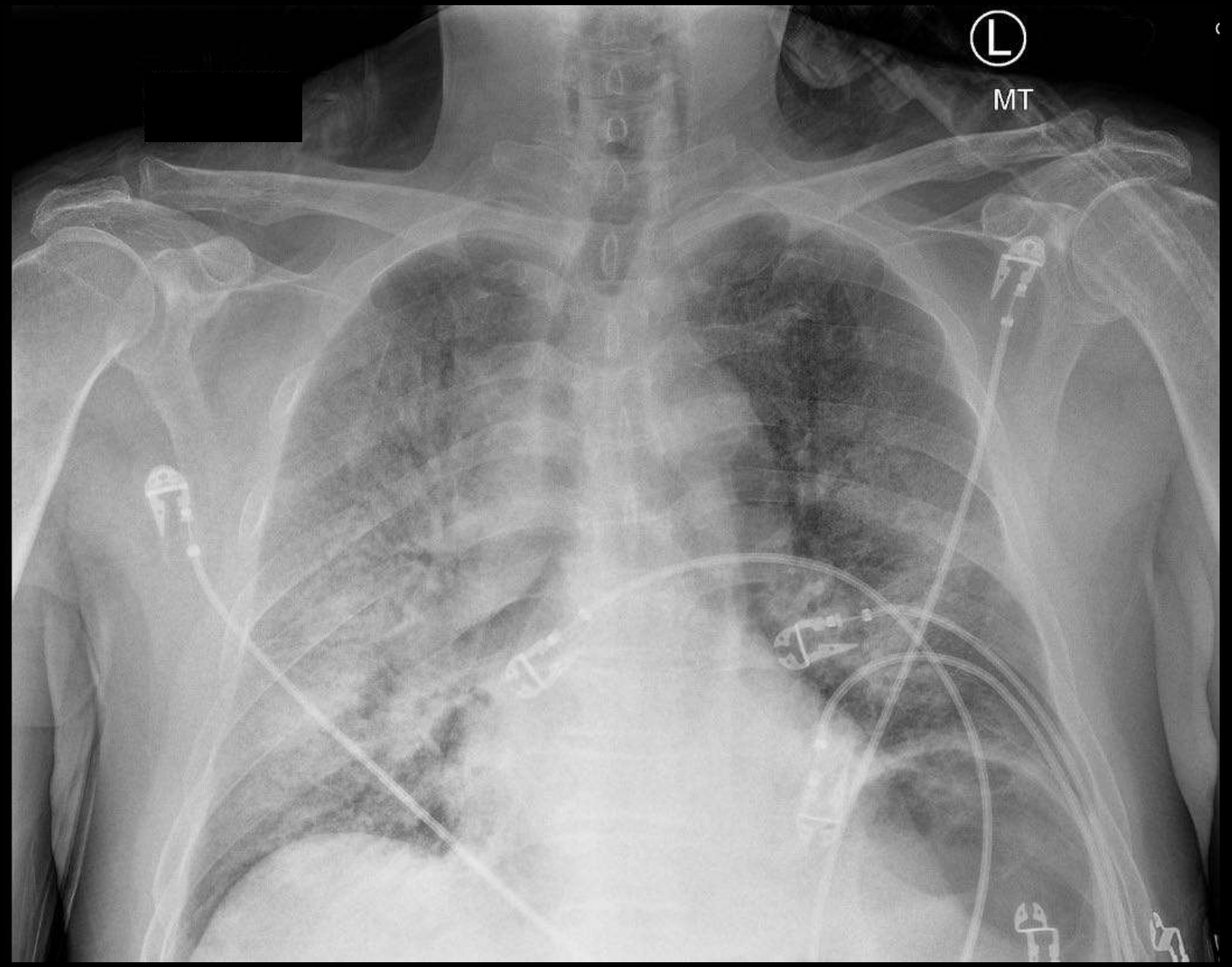
Pre-capillary
Pulmonary hypertension

Post capillary
Pulmonary
hypertension

Respiratory failure phenotypes


[redacted]
Mechanical ventilation
Induced failure
L
MT
60yo male
Legionella pneumonia
↑ Short of breath
Fevers 40°C
NIV FiO2 0.4
Sats 95%
RR 35

FiO2 0.8



Blood Gas Values			
↓ pH	7.287		[7.350 - 7.450]
pCO_2	39.3	mmHg	[35.0 - 45.0]
↑ pO_2	123	mmHg	[75.0 - 105]
Acid Base Status			
↓ $cBase(B)_c$	-7.6	mmol/L	[-3.0 - 3.0]
↓ $cHCO_3^-(P)_c$	18.2	mmol/L	[22.0 - 28.0]
Oximetry Values			
ctHb	146	g/L	[130 - 170]
Hct_c	44.9	%	[-]
sO_2	98.3	%	[95.0 - 99.0]
FO_2Hb	96.4	%	[90.0 - 98.0]
FCOHb	1.1	%	[0.3 - 1.8]
FMetHb	0.8	%	[0.4 - 1.2]
FHHb	1.7	%	[-]
Oxygen Status			
$ctO_{2}c$	20.0	Vol%	
$pO_2(a)/FO_2(I)_c$	307	mmHg	[-]
$p50_e$	29.37	mmHg	[-]
Electrolyte Values			
↓ cNa^+	132	mmol/L	[136 - 146]
↑ cK^+	5.5	mmol/L	[3.7 - 4.7]
↓ cCa^{2+}	1.08	mmol/L	[1.15 - 1.30]
cCl^-	107	mmol/L	[101 - 110]
Anion Gap_c	6.0	mmol/L	[-
Metabolite Values			
↑ cGlu	6.9	mmol/L	[3.5 - 5.4
↑ cLac	2.9	mmol/L	[0.0 - 2.0

The New England Journal of Medicine

VOLUME 342 MAY 4, 2000 NUMBER 18

VENTILATION WITH LOWER TIDAL VOLUMES AS COMPARED WITH TRADITIONAL TIDAL VOLUMES FOR ACUTE LUNG INJURY AND THE ACUTE RESPIRATORY DISTRESS SYNDROME

THE ACUTE RESPIRATORY DISTRESS SYNDROME NETWORK*

ARDSnet FiO2/PEEP Titration

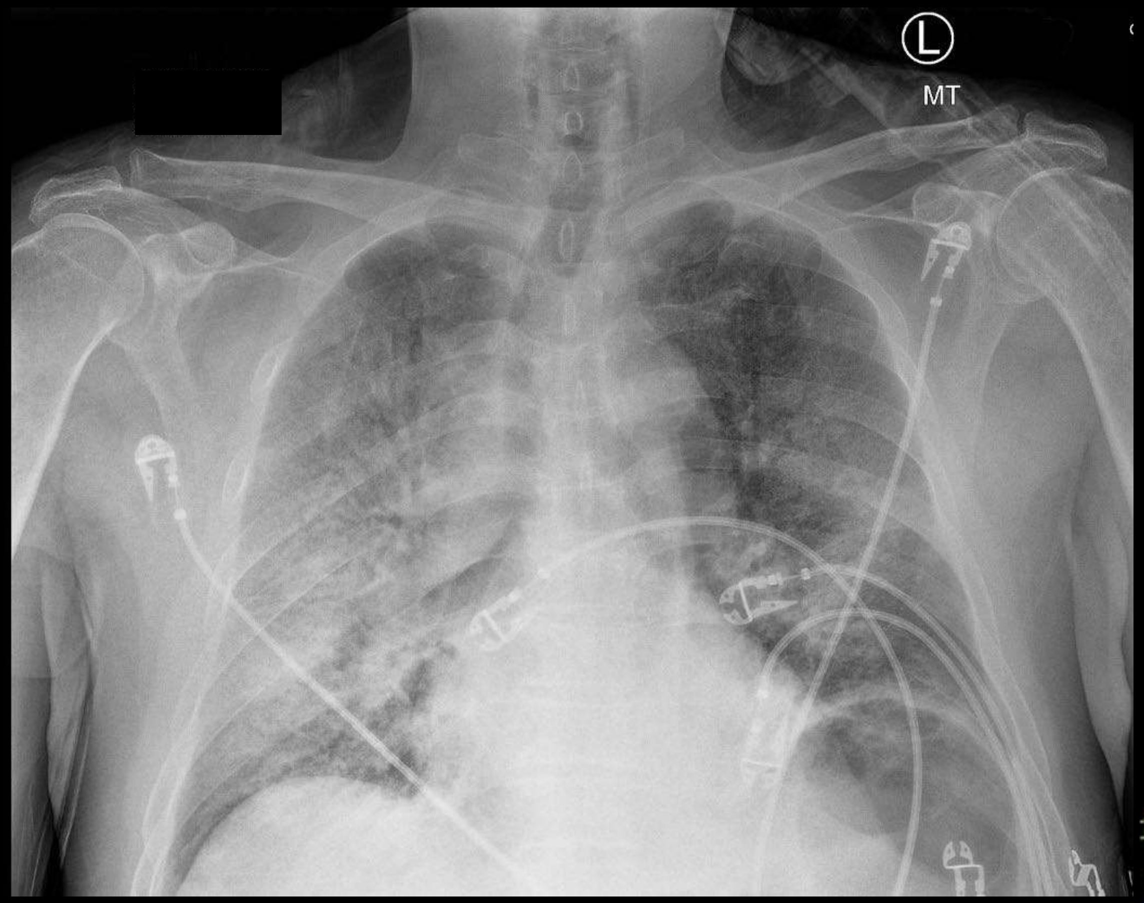
Goal O2 Sat 88 - 95% (PaO2 55 - 80mmHg)

Wait 5 - 10 min Before Step Up or Down
(Titrate FiO2/PEEP at Same Time)

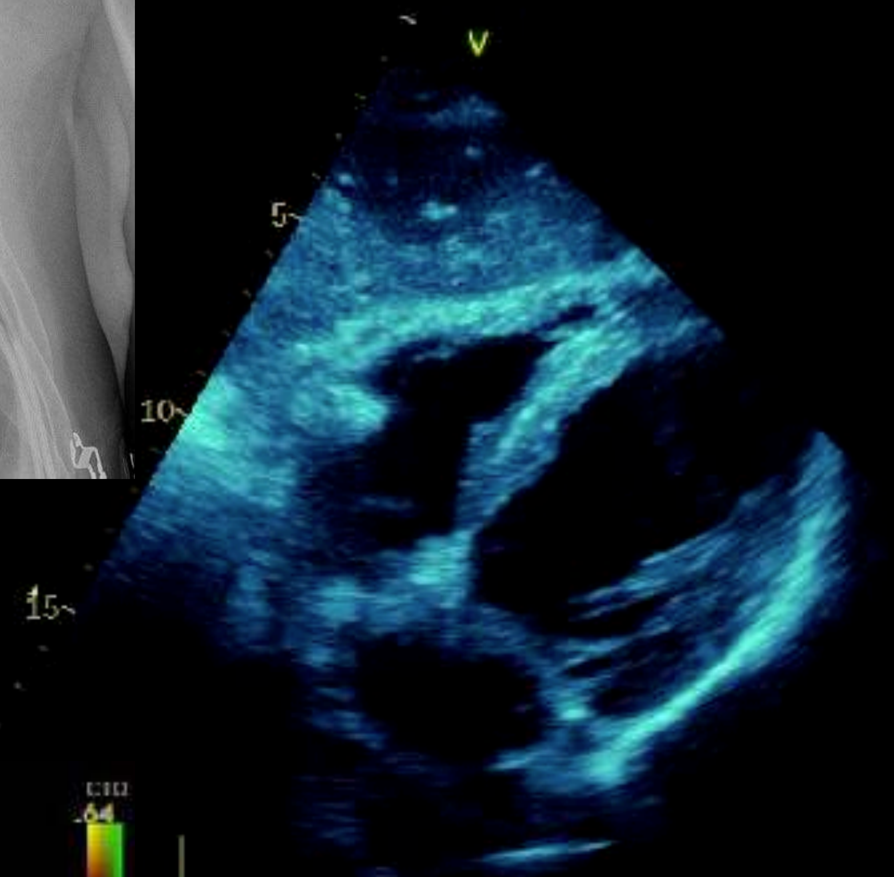
FiO2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

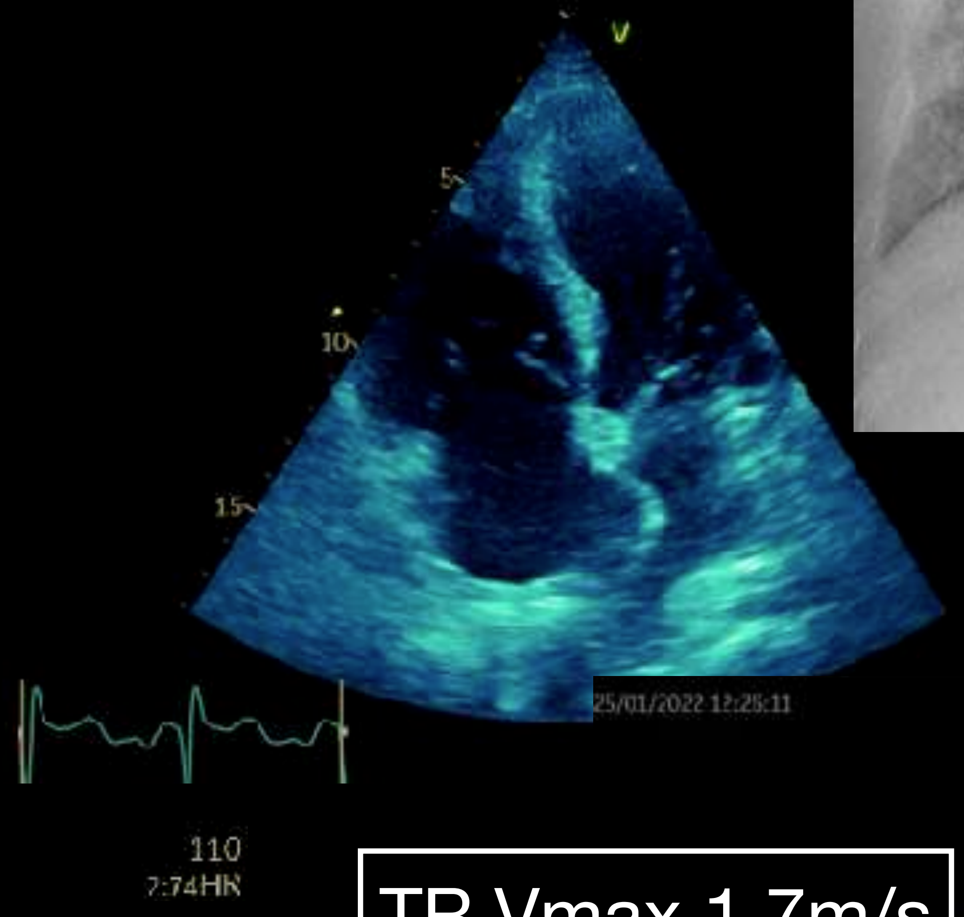
REBELEM

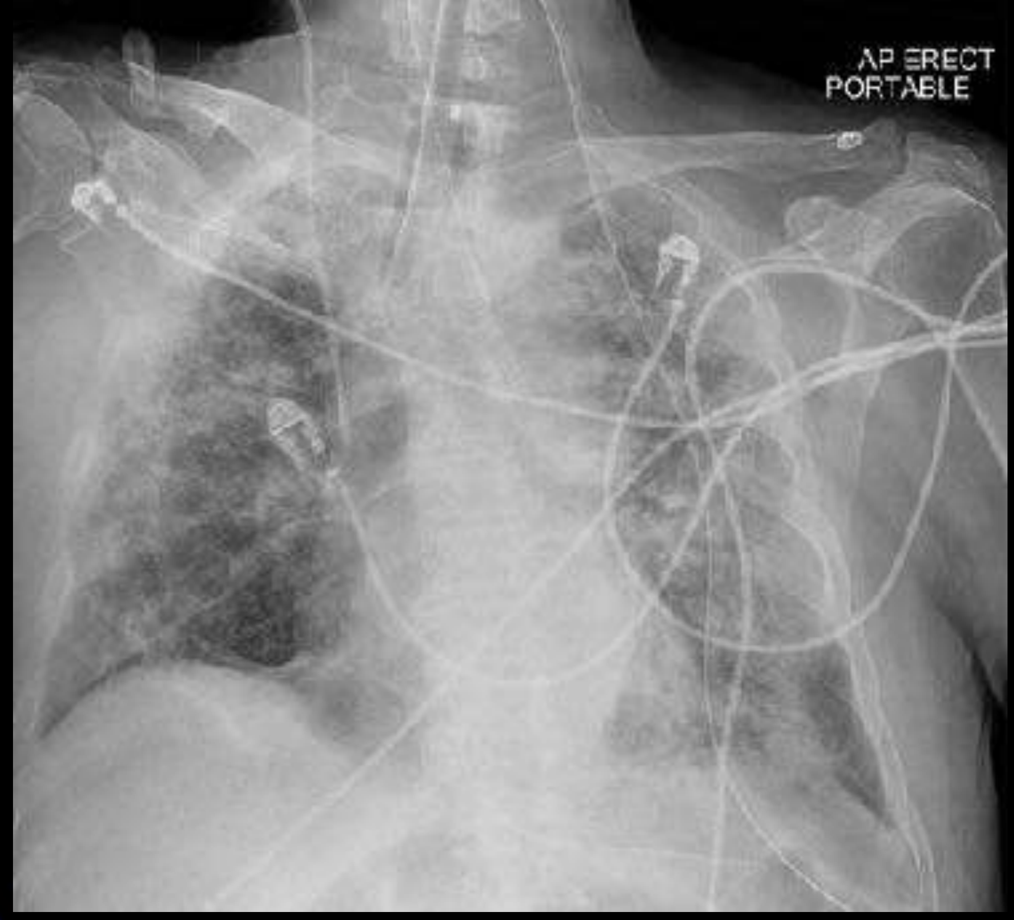


Pre ETT

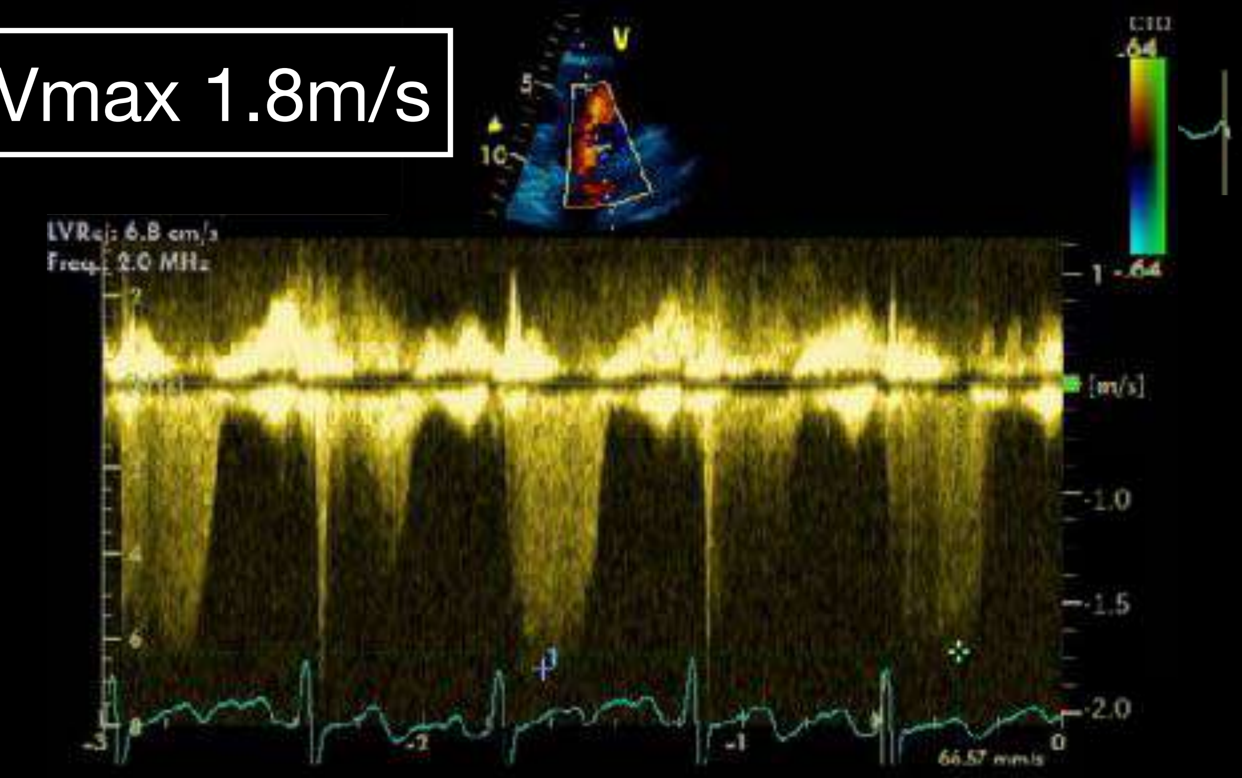


Post intubation
PEEP 14

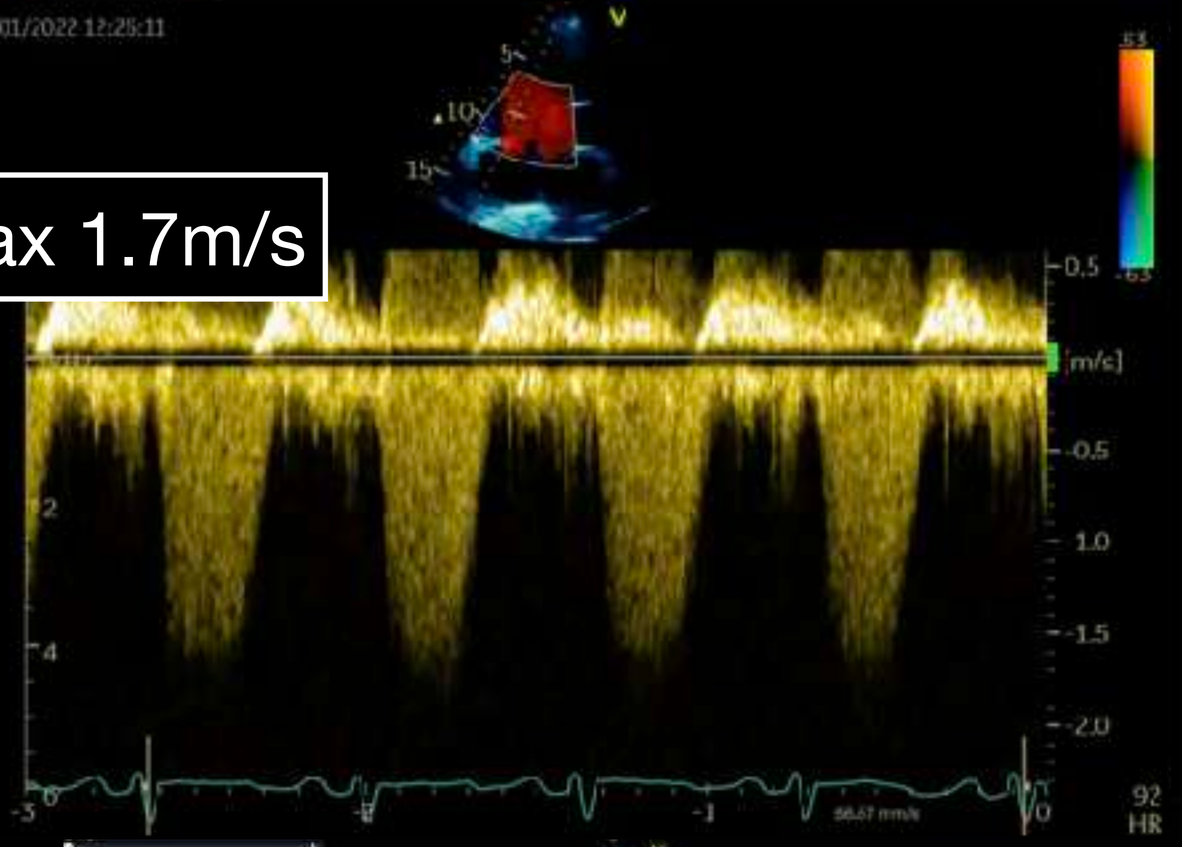




TR Vmax 1.8m/s



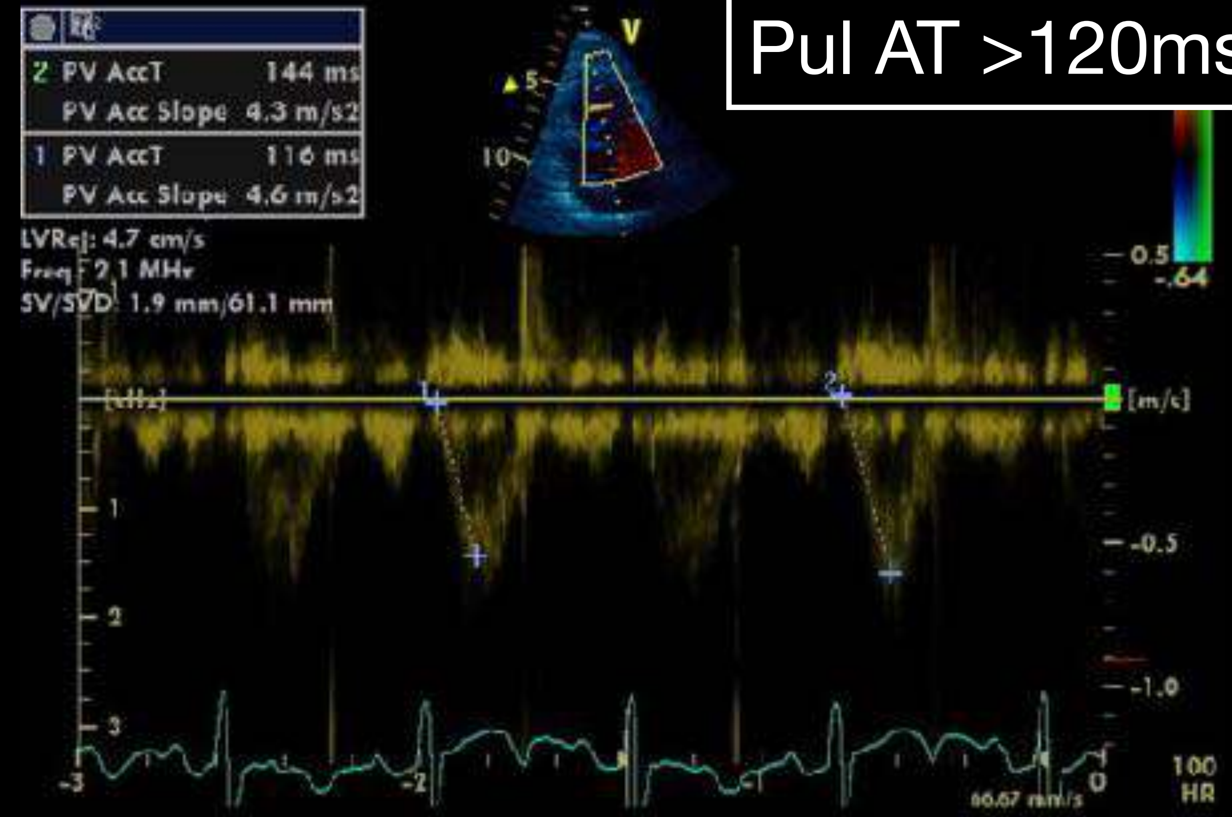
TR Vmax 1.7m/s



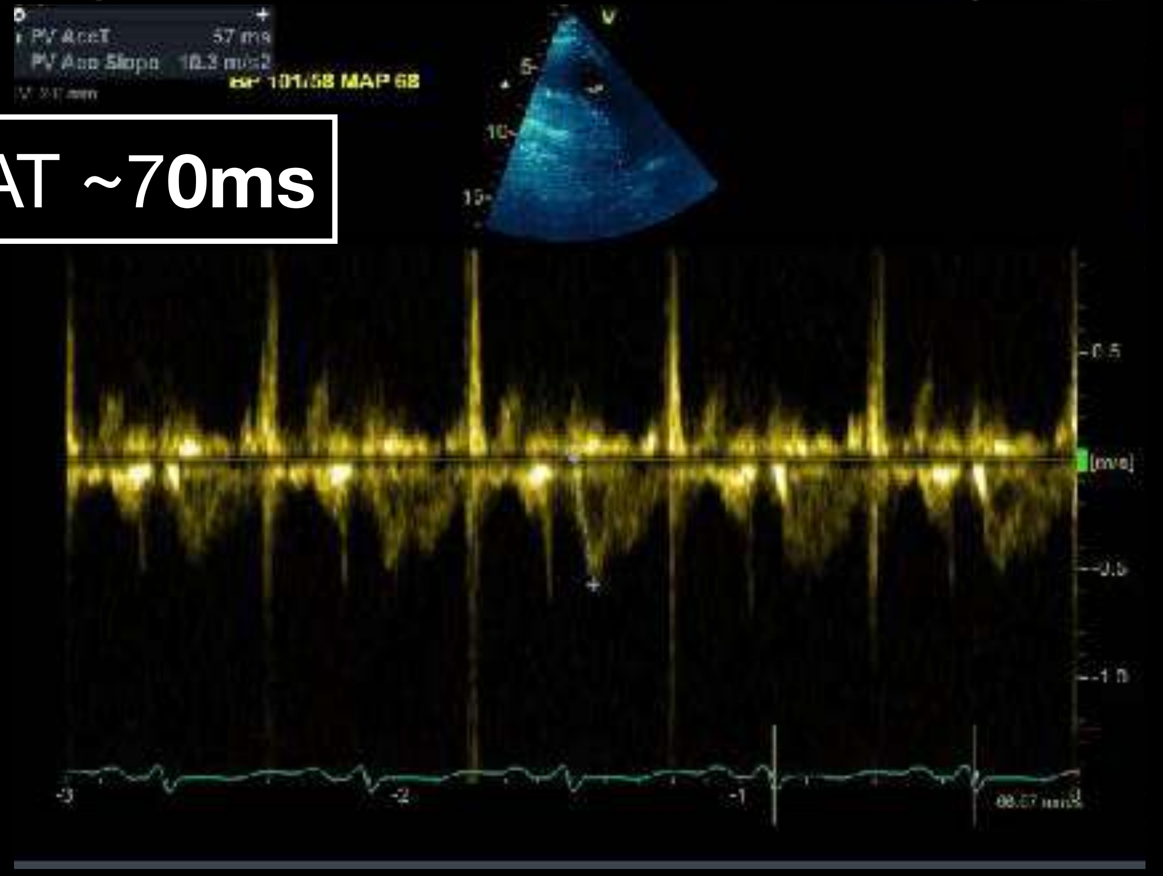
Post intubation

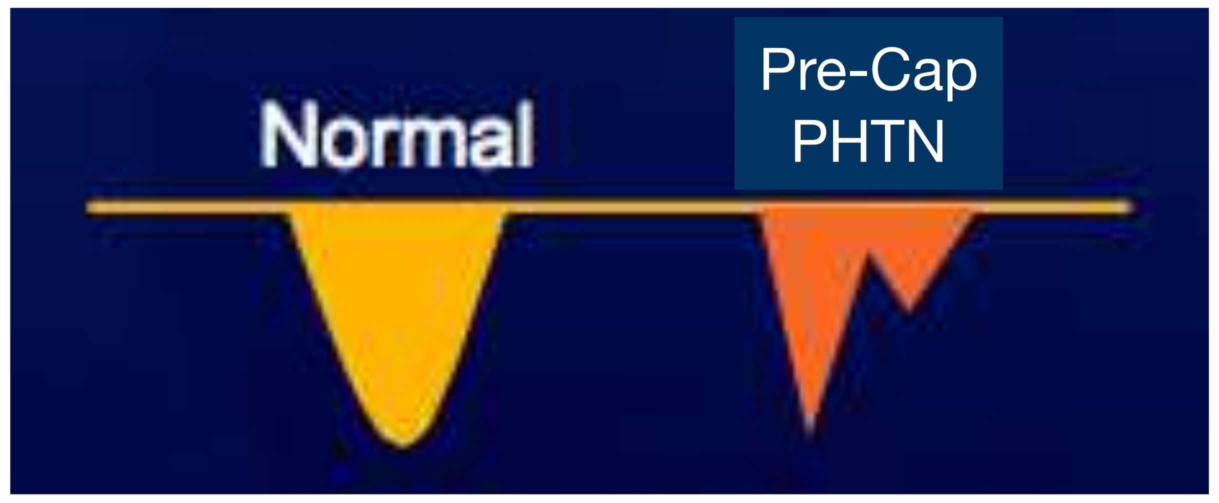
- RV dysfunction
- Pul Vasc resistance increase
- Worse pre-cap pul HTN
- Uncoupling of RV - PA system

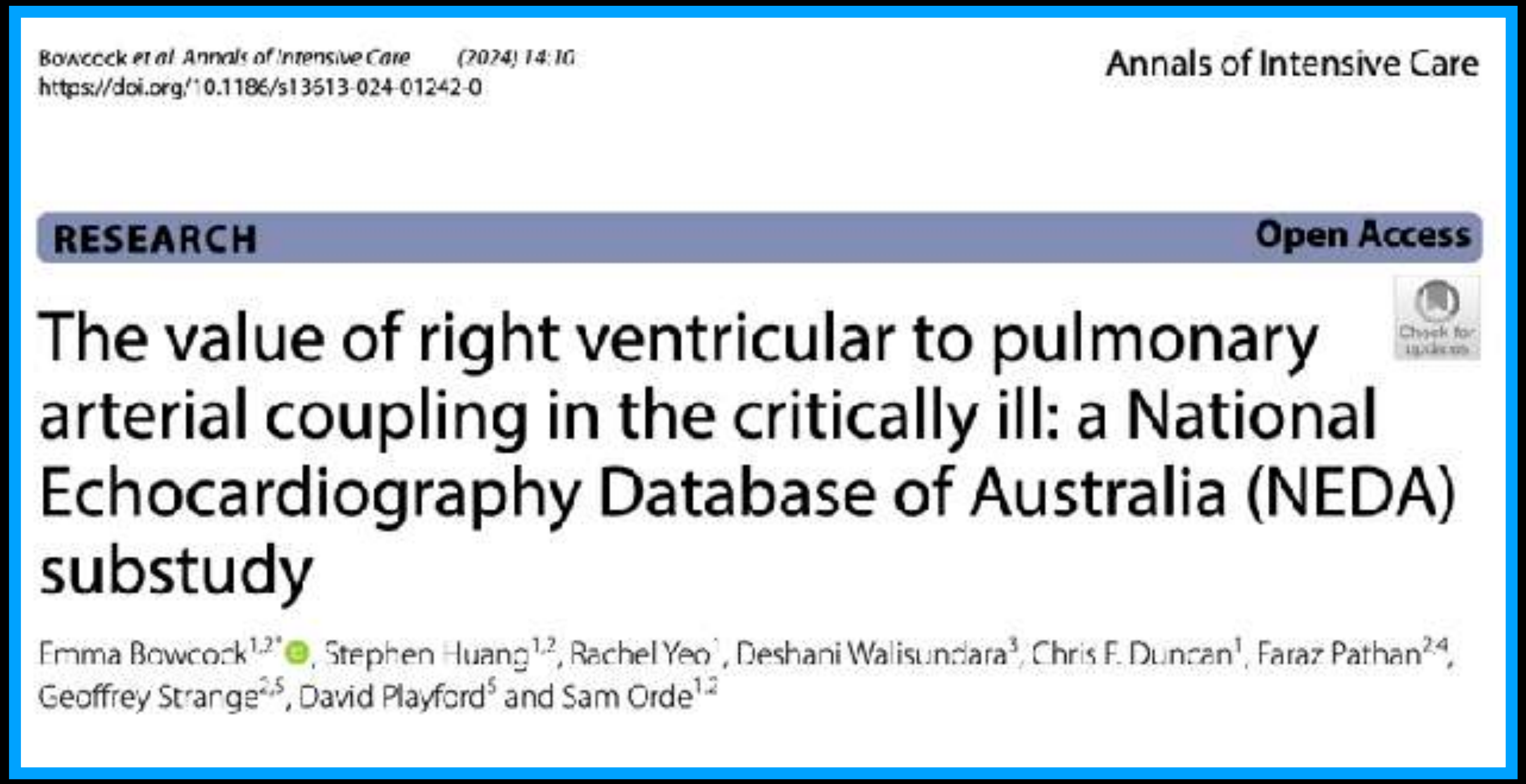
Pul AT >120ms



Pul AT ~70ms






Bowcock et al. Annals of Intensive Care (2024) 14:10
https://doi.org/10.1186/s13613-024-01242-0

Annals of Intensive Care

RESEARCH Open Access

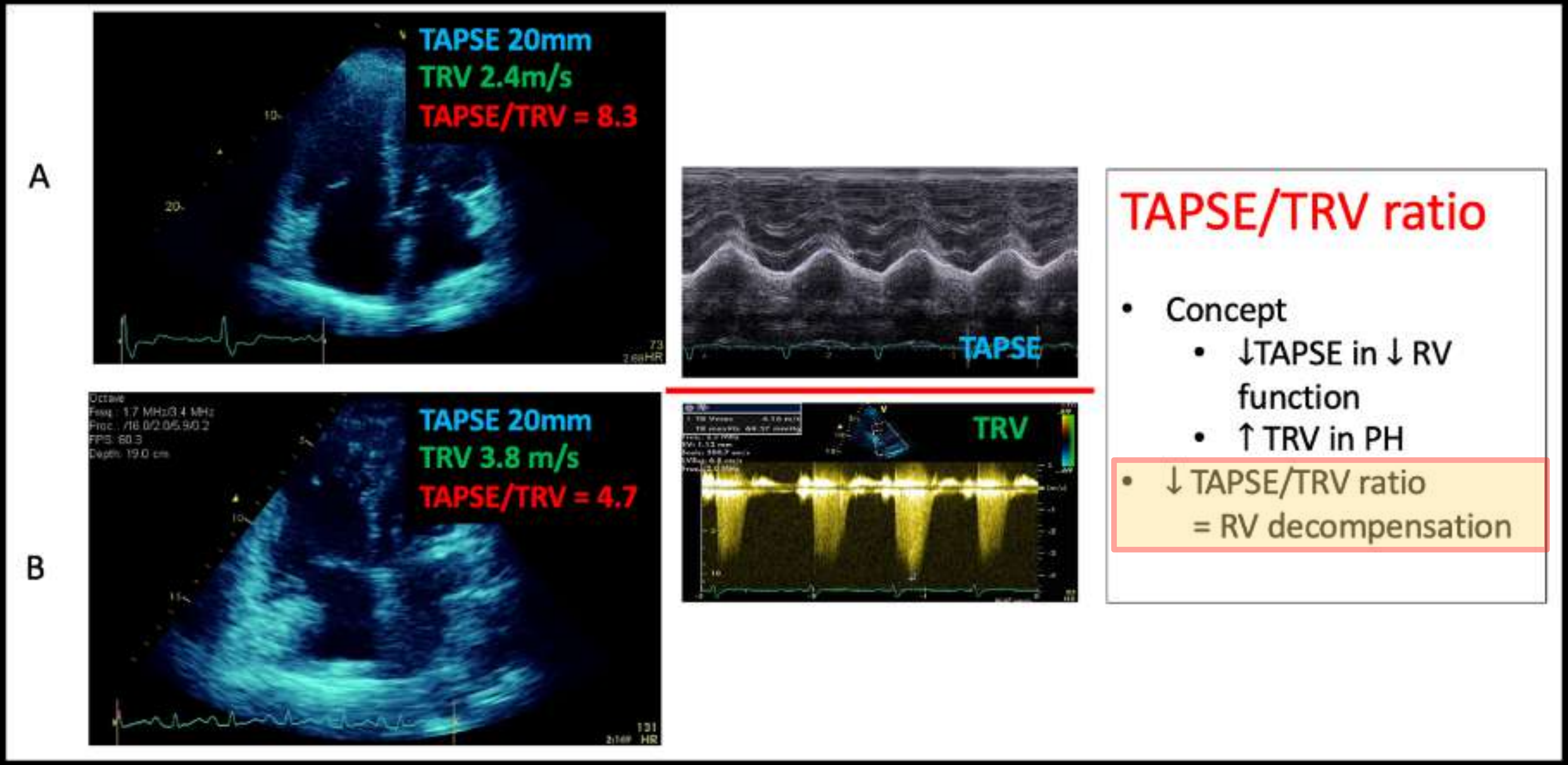
The value of right ventricular to pulmonary arterial coupling in the critically ill: a National Echocardiography Database of Australia (NEDA) substudy

Emma Bowcock[1,2*], Stephen Huang[1,2], Rachel Yeo[1], Deshani Walisundara[3], Chris F. Duncan[1], Faraz Pathan[2,4], Geoffrey Strange[2,5], David Playford[5] and Sam Orde[1,2]

Retrospective 5yr review
1077 ICU patients having an echo
Echo, clinical and long term outcome analysis

RV-PA coupling = effective transfer of energy
RV-PA 'uncoupling' = RV decompensation
Prognostic in pulmonary hypertension literature

RV - PA coupling



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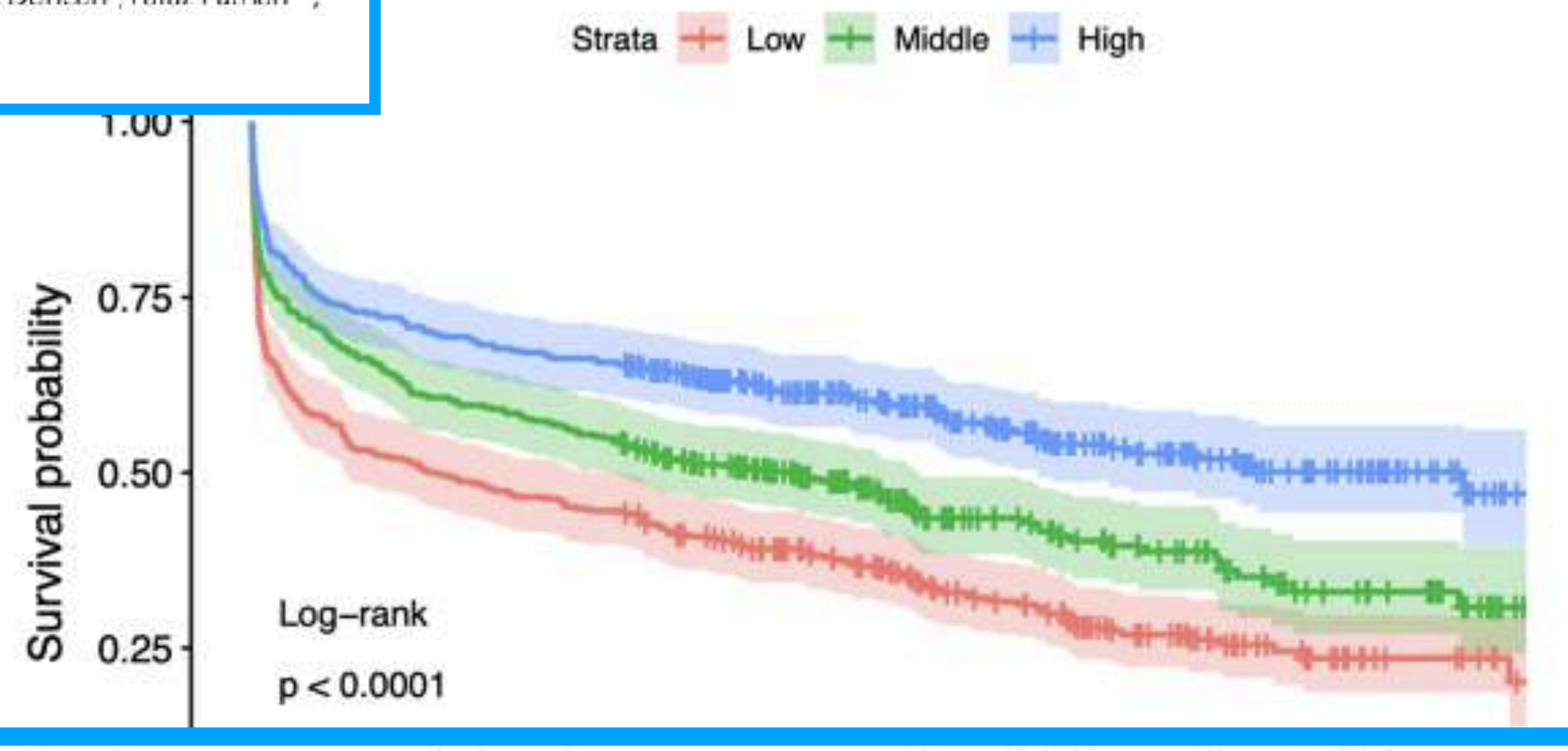
Retrospective 5yr review
1077 ICU patients having an echo
Echo, clinical and long term outcome analysis

Higher the TAPSE/TRV the better the coupling
Worsening RV-PA uncoupling highly prognostic

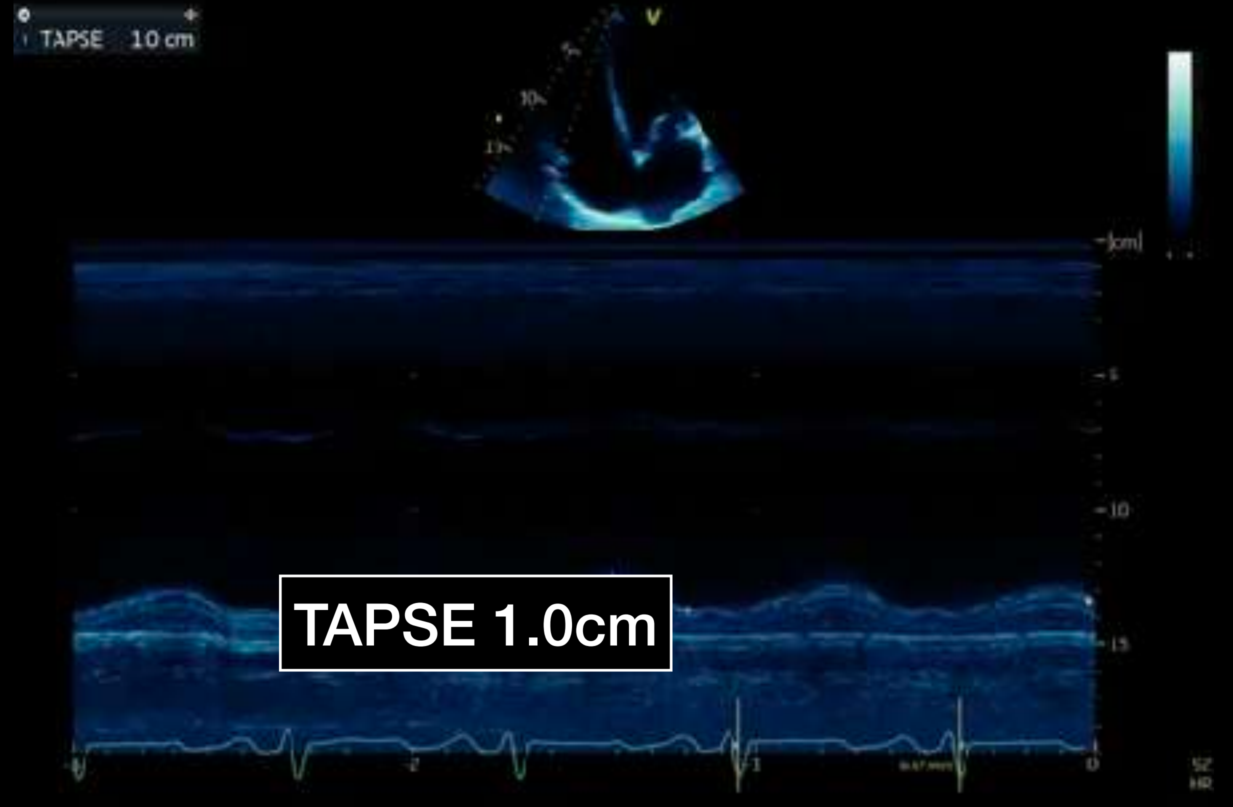


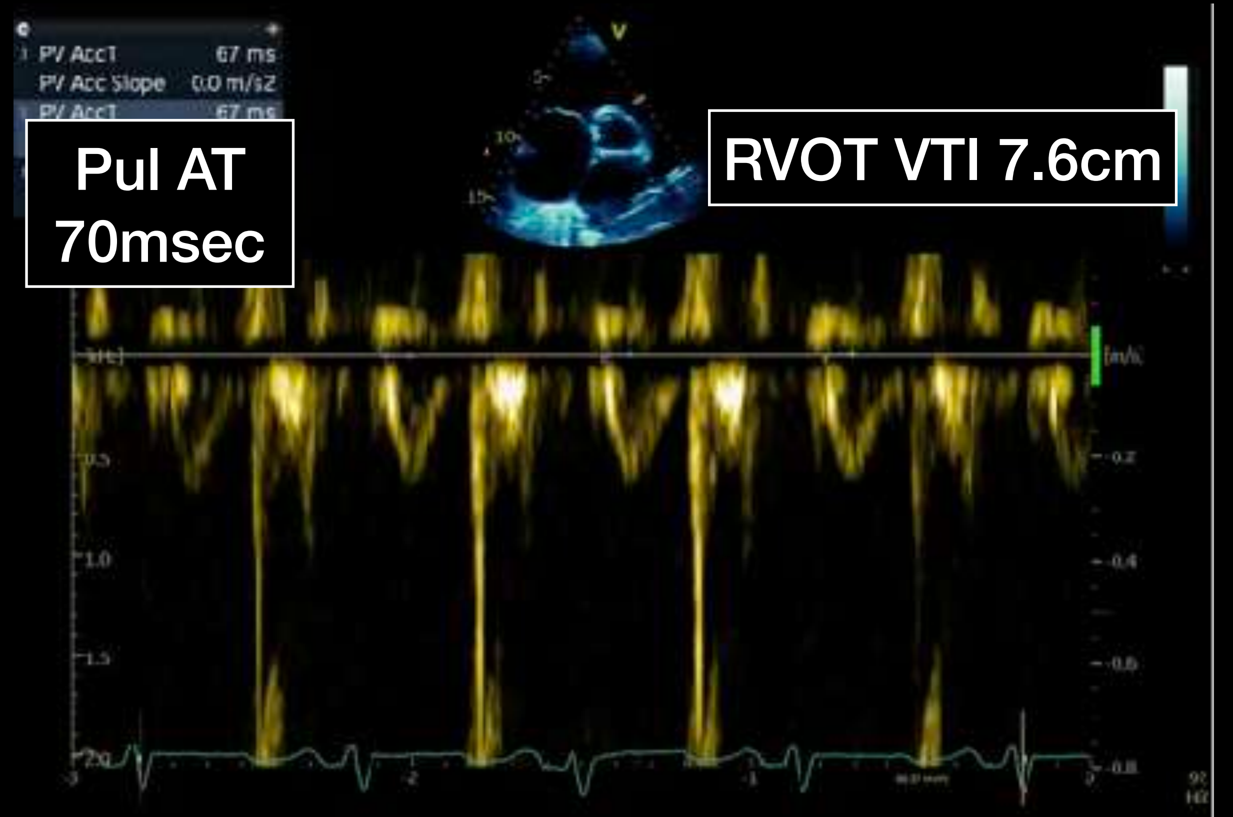
Conclusion The TAPSE/TRV ratio has prognostic relevance in critically ill patients. The prognostic power may be stronger in respiratory and septic subgroups. Larger prospective studies are needed to investigate the role of TAPSE/TRV in pre-specified subgroups including its role in clinical decision-making.

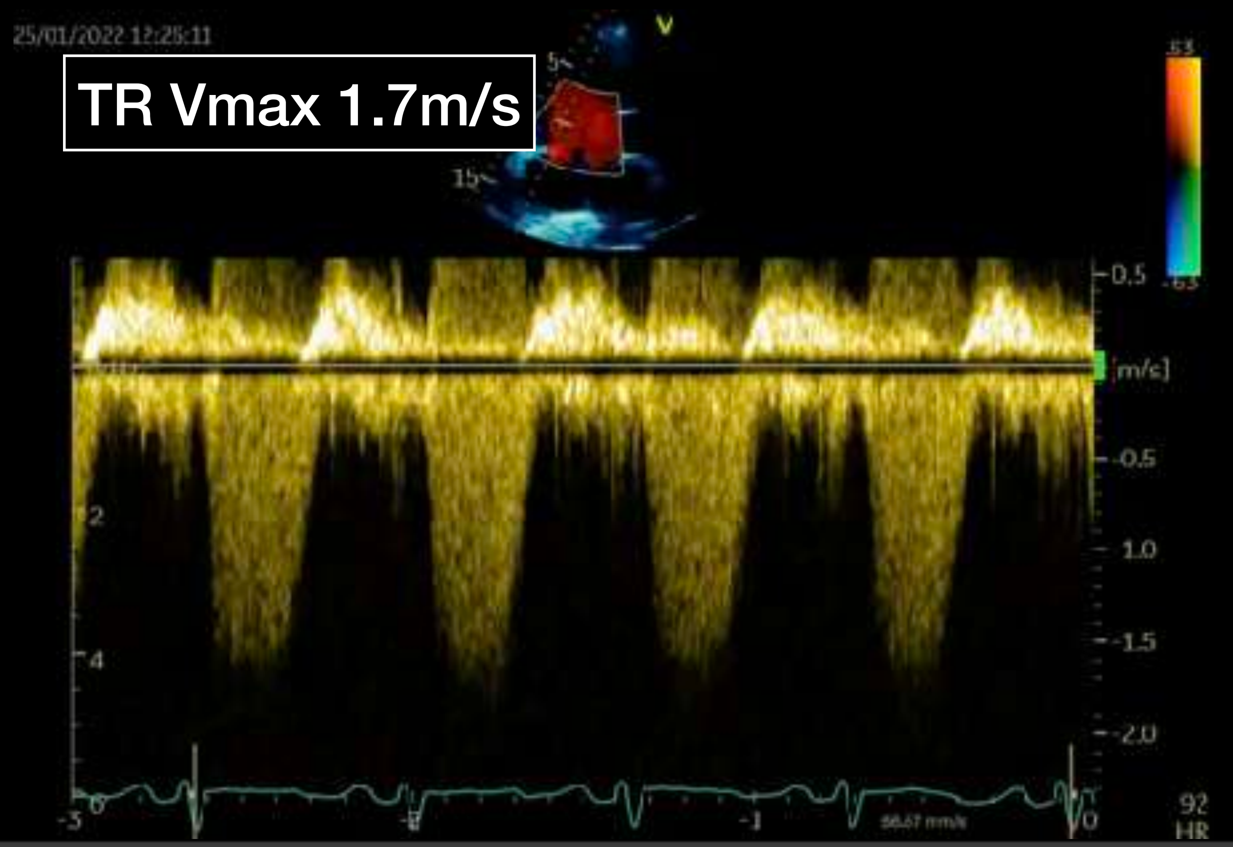
Characteristic	N	HR	95% CI	P value
TAPSE/TRV tertiles	1077			
Low (<5.9 mm.(m/s)$^{-1}$)		-	-	
Middle (≥5.9 to 8.02 mm.(m/s)$^{-1}$)		0.73	0.61-0.88	<0.001
High (≥8.03 mm.(m/s)$^{-1}$)		0.49	0.40- 0.60	<0.001

Fig. 5 Kaplan–Meier survival analysis and Cox hazard regression model by TAPSE/TRV tertile in 1077 patients. Log rank < 0.0001. HR = hazard ratio; 95% CI = 95% confidence interval

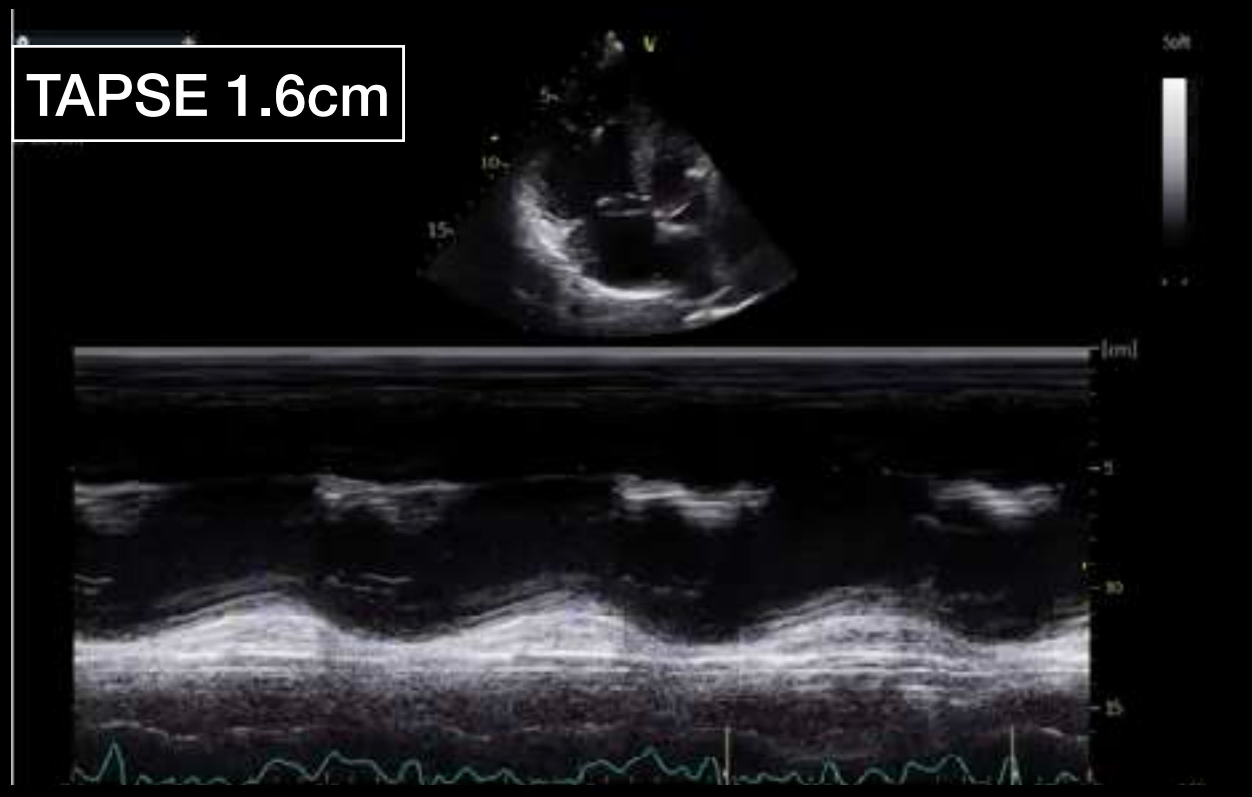
RV-PA coupling

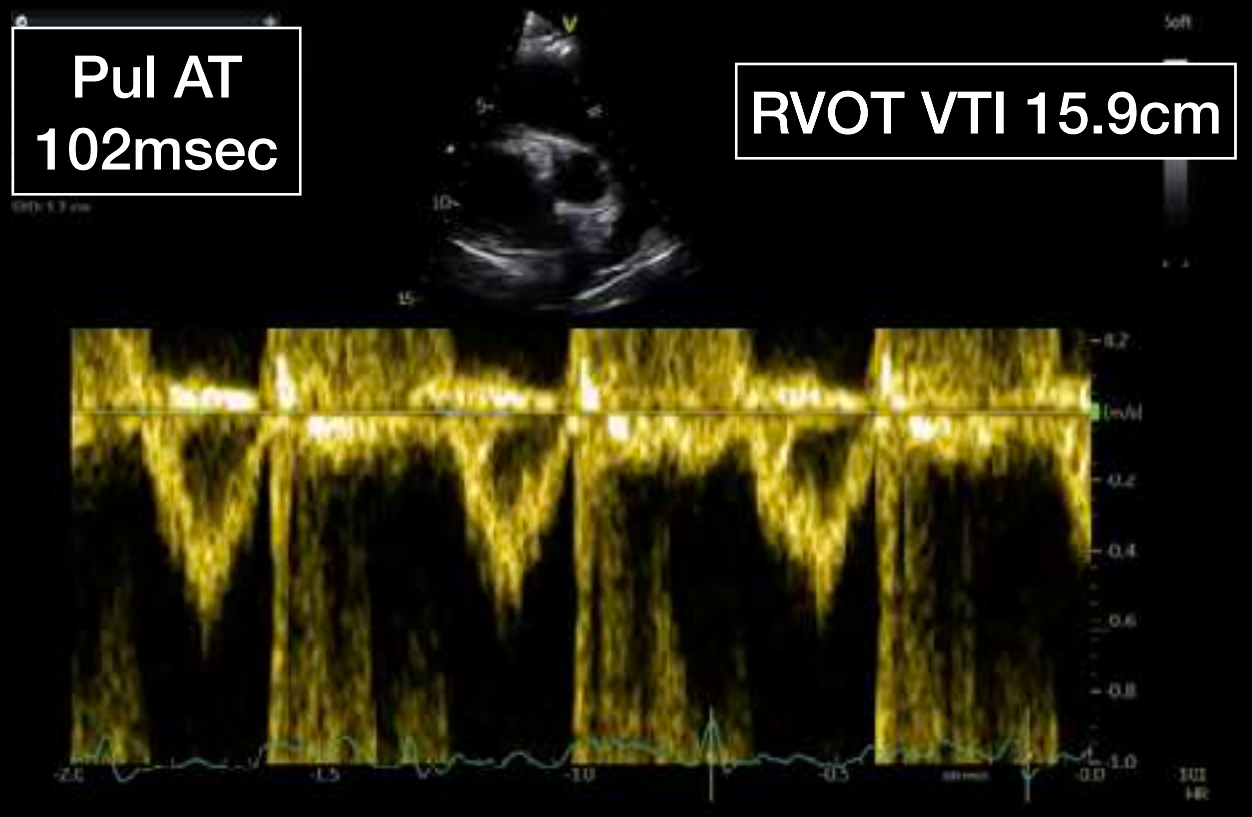


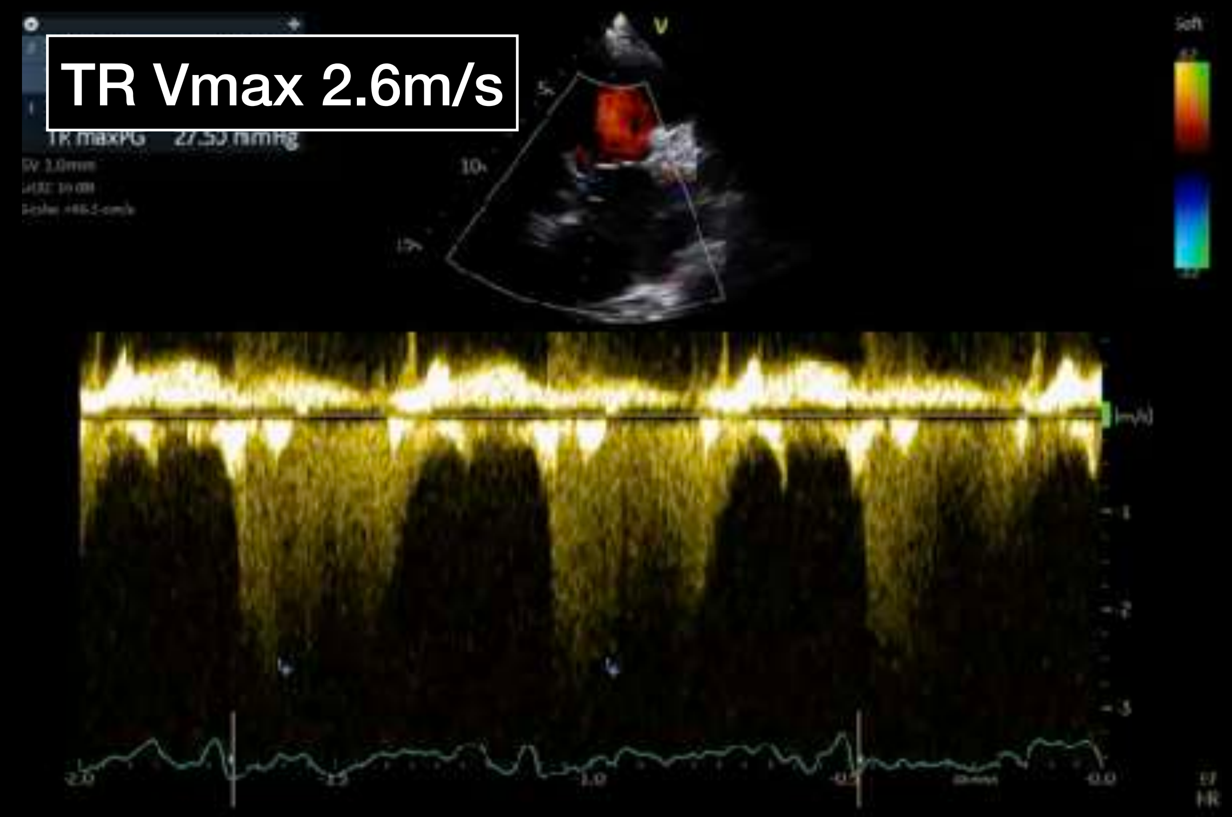




	Noradrenaline infusion	Milronone + noradrenaline infusion
TAPSE	1	1.6
Pul AT (msec)	70	102
RVOT VTI (cm)	7.6	15.9
TR Vmax (m/s)	1.7	2.6
TAPSE/TR Vmax	0.59	0.62
PEEP	14	10

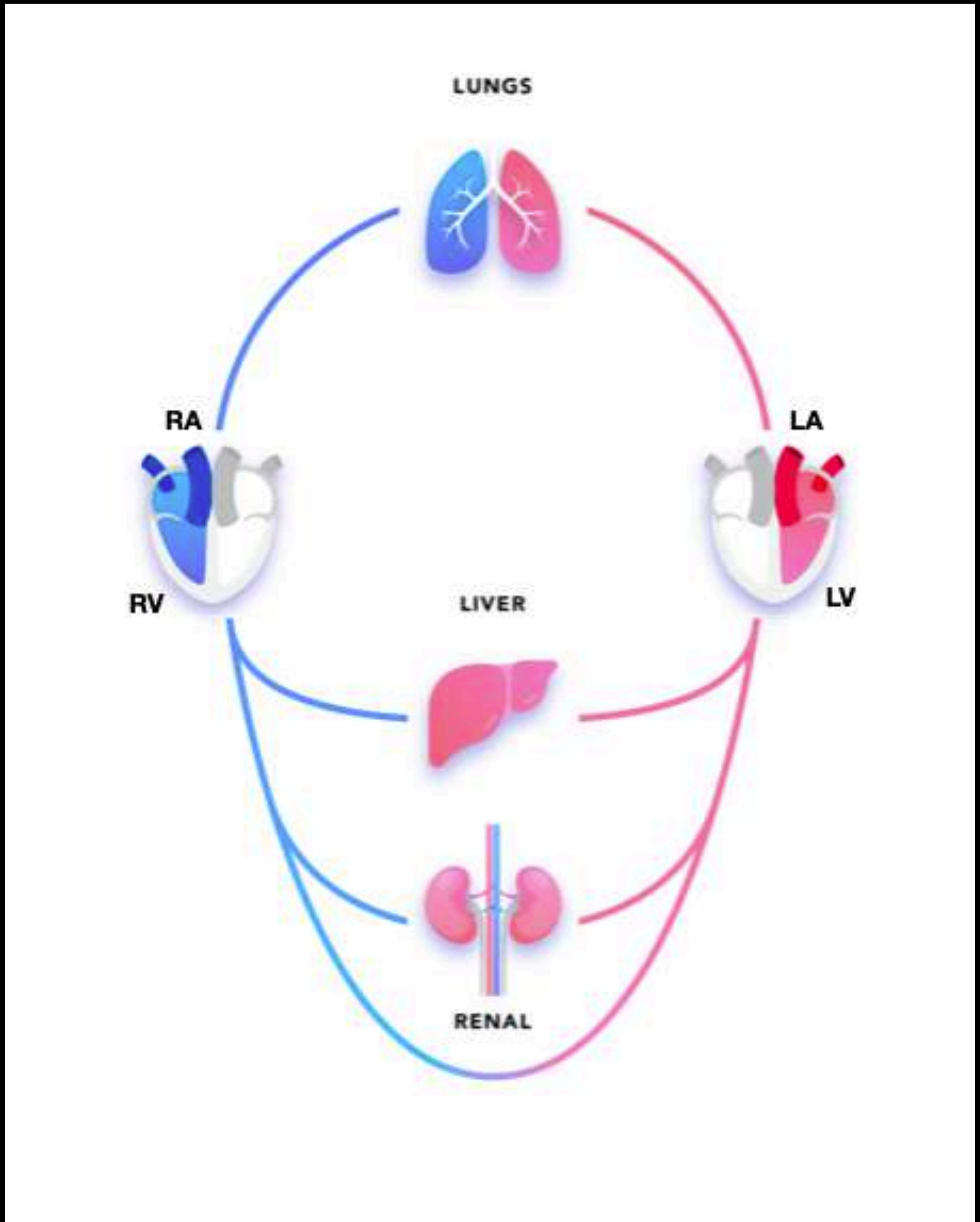






Conclusion

- Echo essential in respiratory failure
- Diagnostic & monitoring tool
- 'See the whole heart'
- Avoid using single echo measures in isolation
- Integrate findings with clinical picture



Thank you very much for listening

YouTube = **Echo at Nepean**

sam.orde@health.nsw.gov.au