Kantonsspital
St.Gallen

ESC/ERS Guidelines 2022
Definition and Diagnosis of PH

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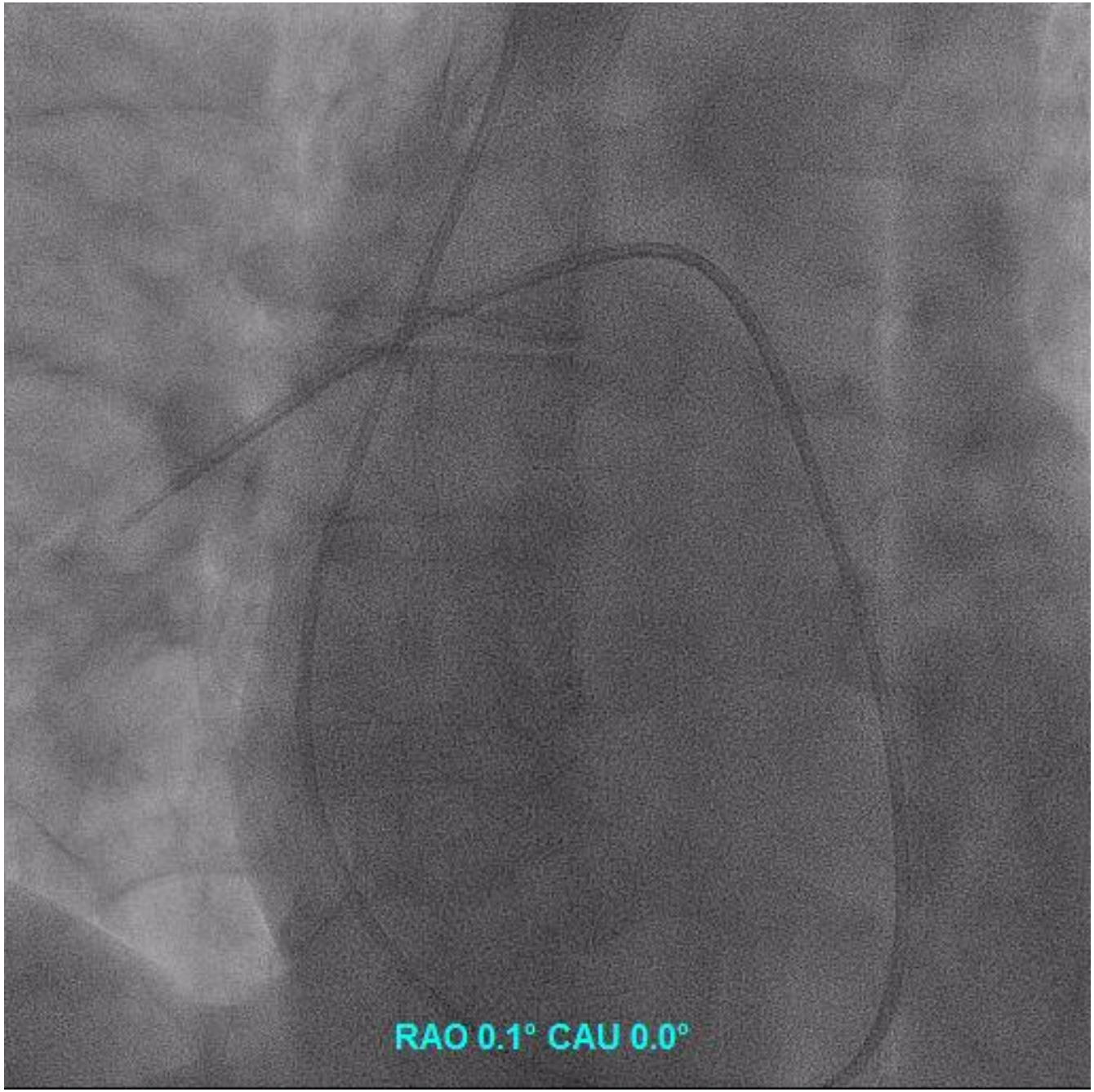
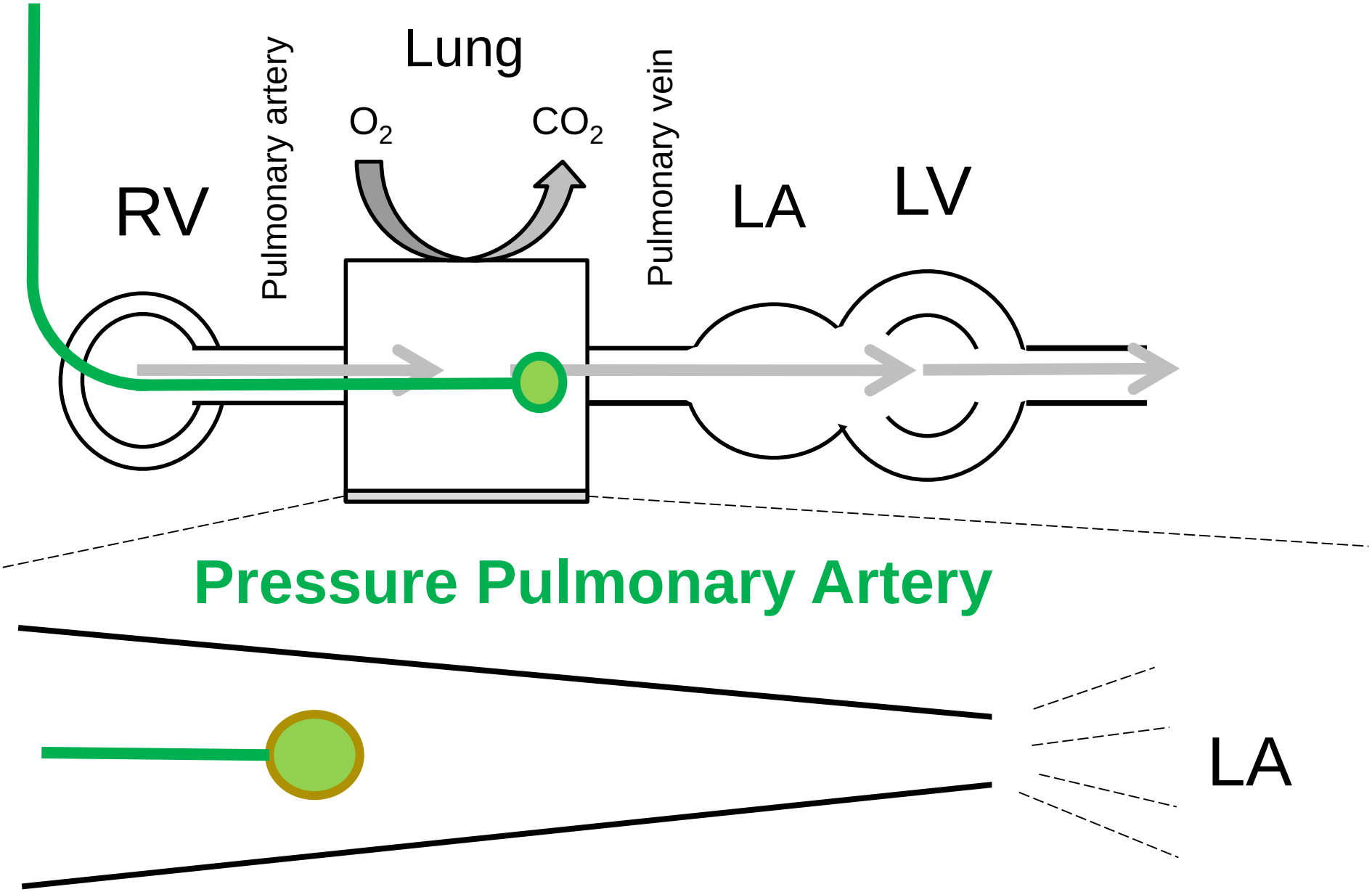
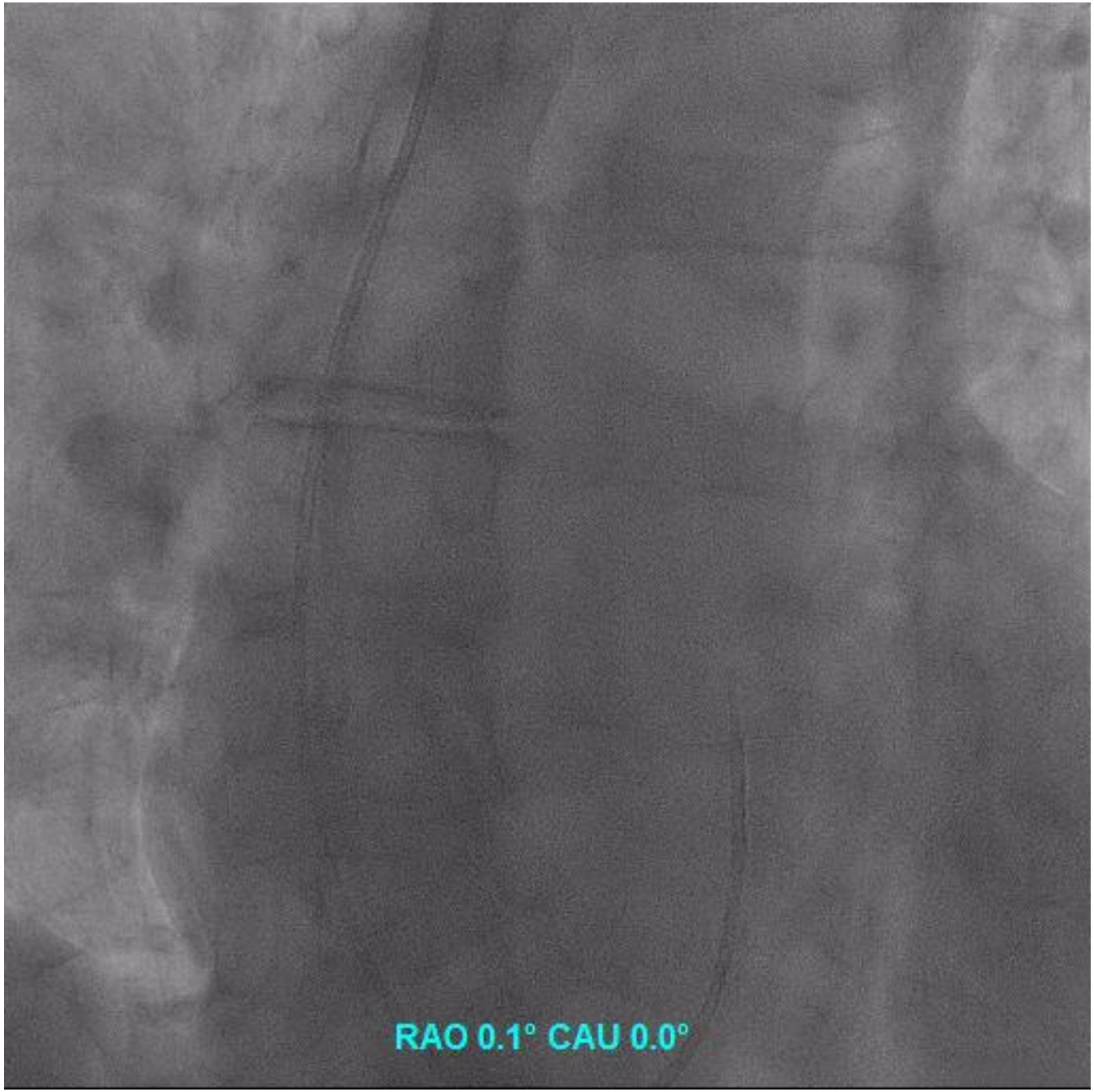
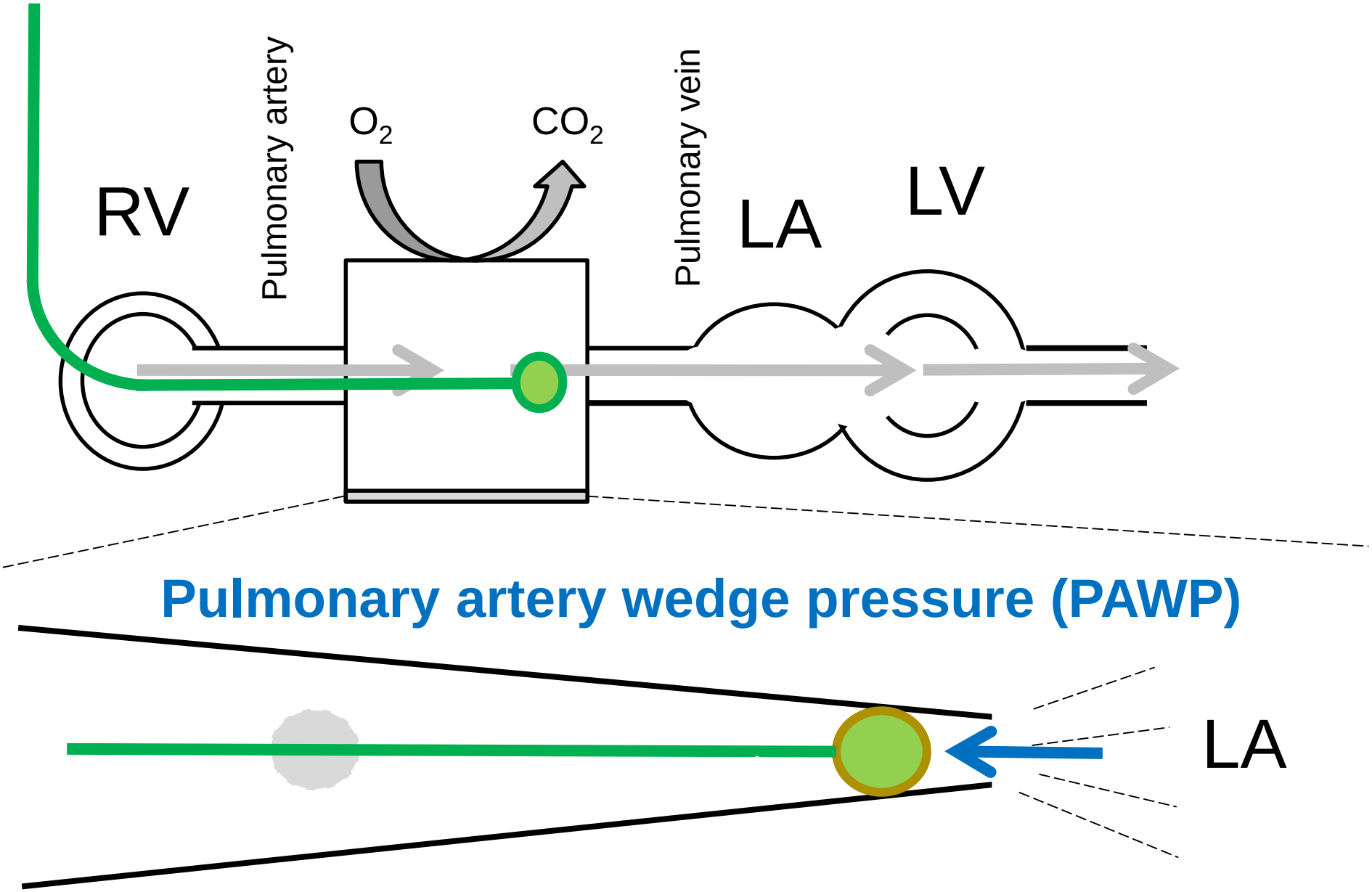
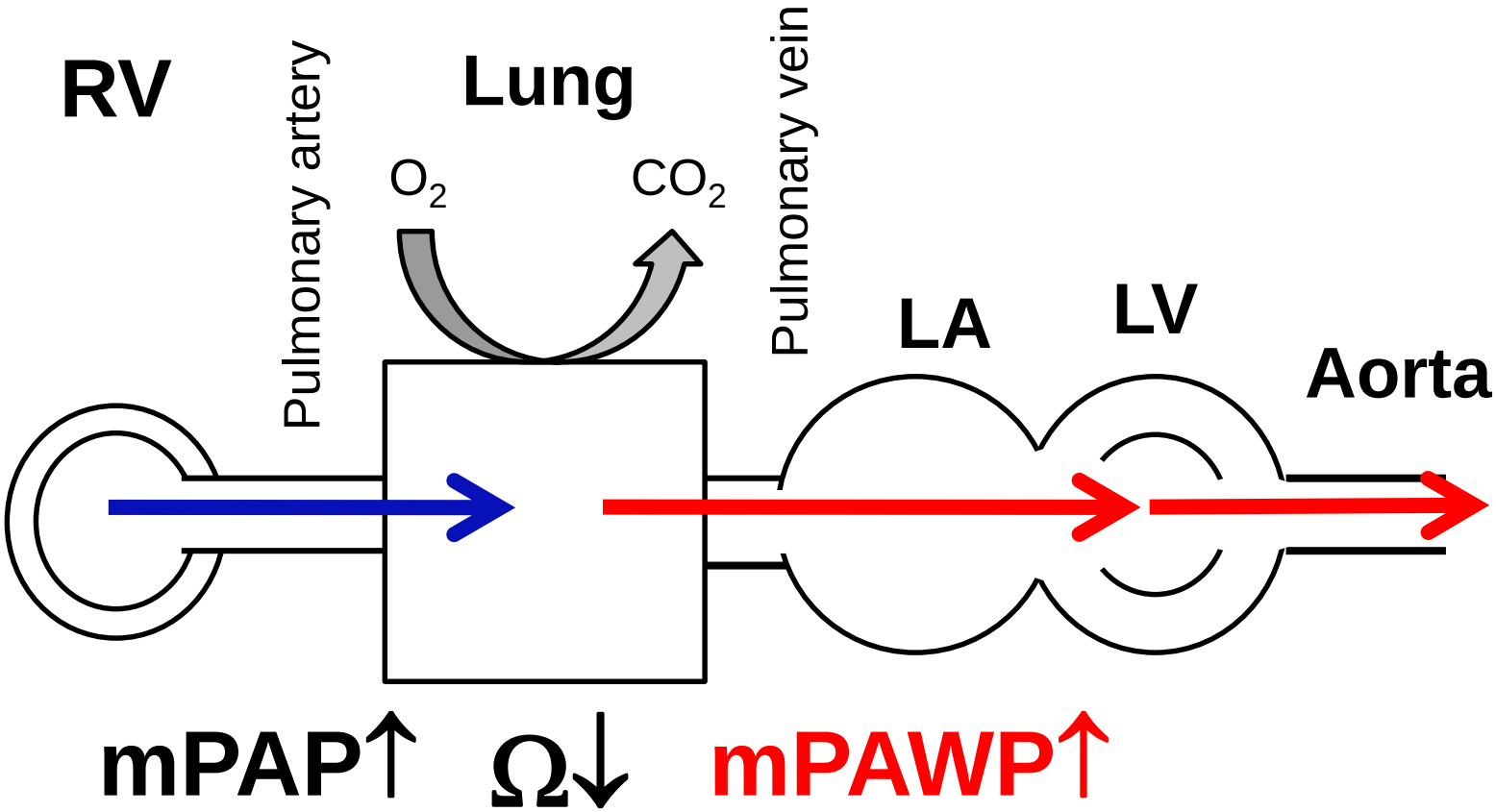

RAO 0.1° CAU 0.0°


Lung
Pulmonary artery
O_2
CO_2
Pulmonary vein
RV
LA
LV
Pressure Pulmonary Artery
LA


RAO 0.1° CAU 0.0°


RV
Pulmonary artery
O_2
CO_2
Pulmonary vein
LA
LV
Pulmonary artery wedge pressure (PAWP)
LA



Post-capillary PH

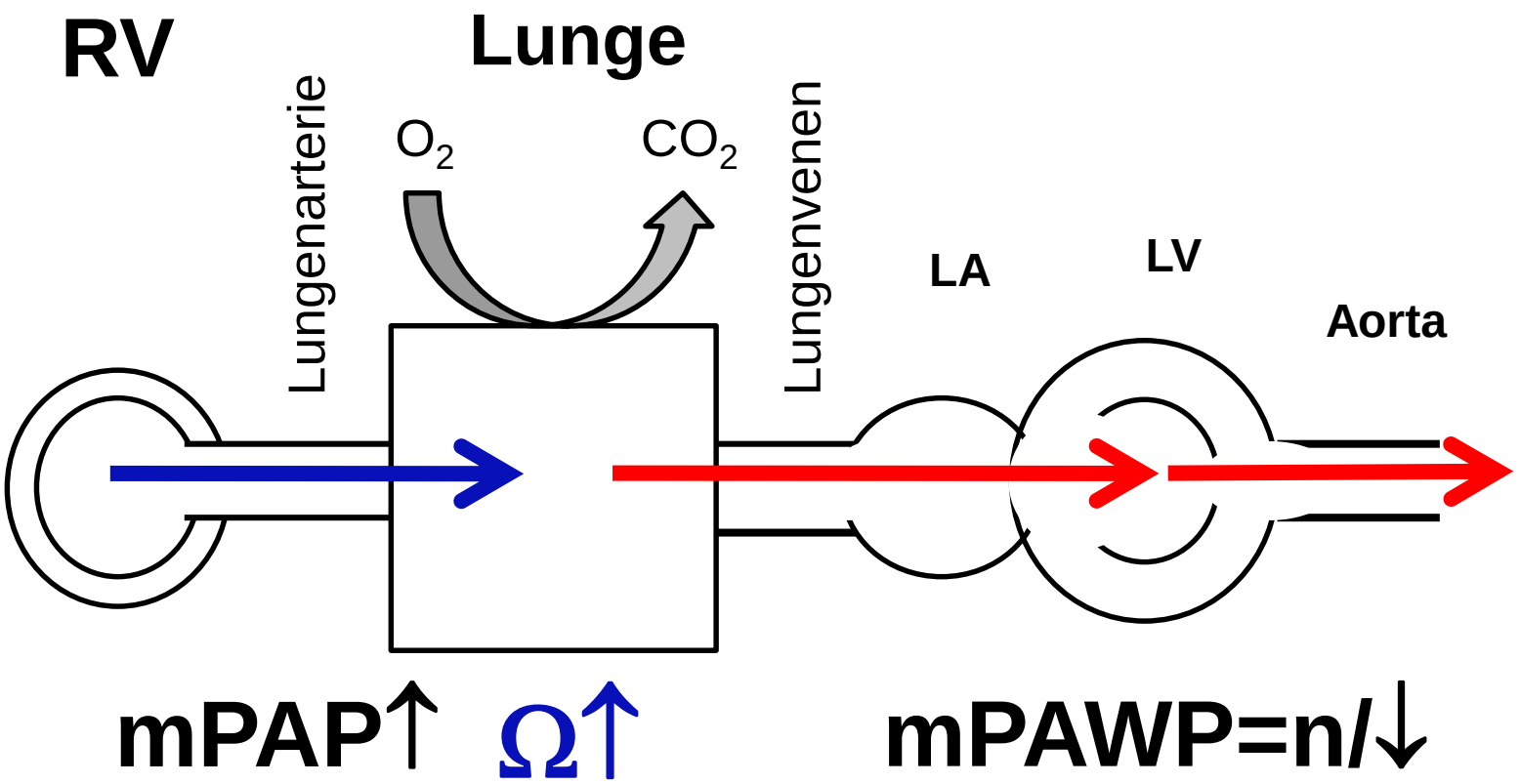
mPAP **mPAWP↑**

TPG

TPG=mPAP-mPAWP

PVR = TPG / CO

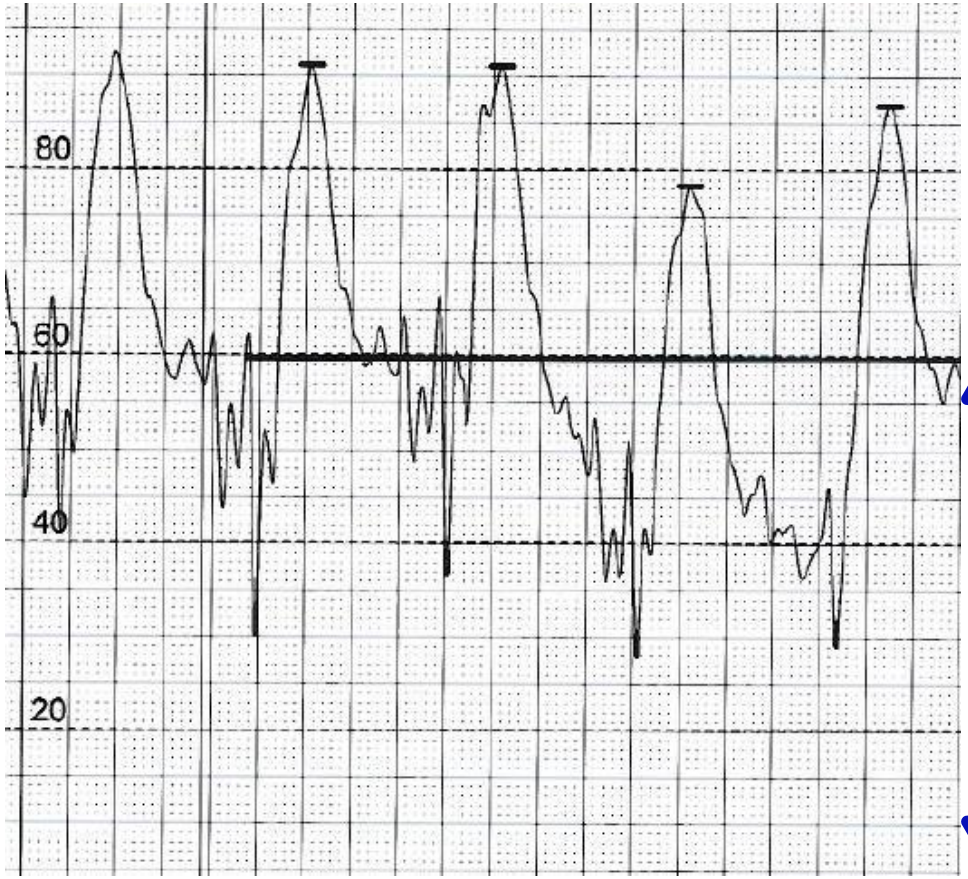
Transpulmonary Gradient (TPG)↓, i.e. PVR ↓



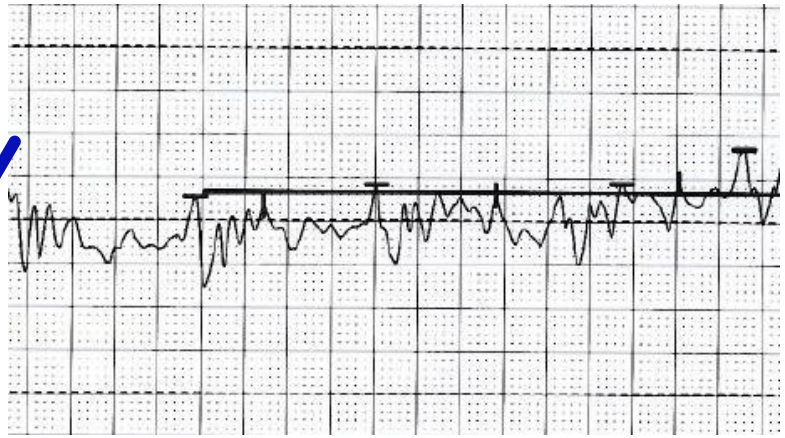
Pre-capillary pulmonary hypertension

mPAP

mPAWP↓



Transpulmonary Gradient (TPG) and PVR ↑

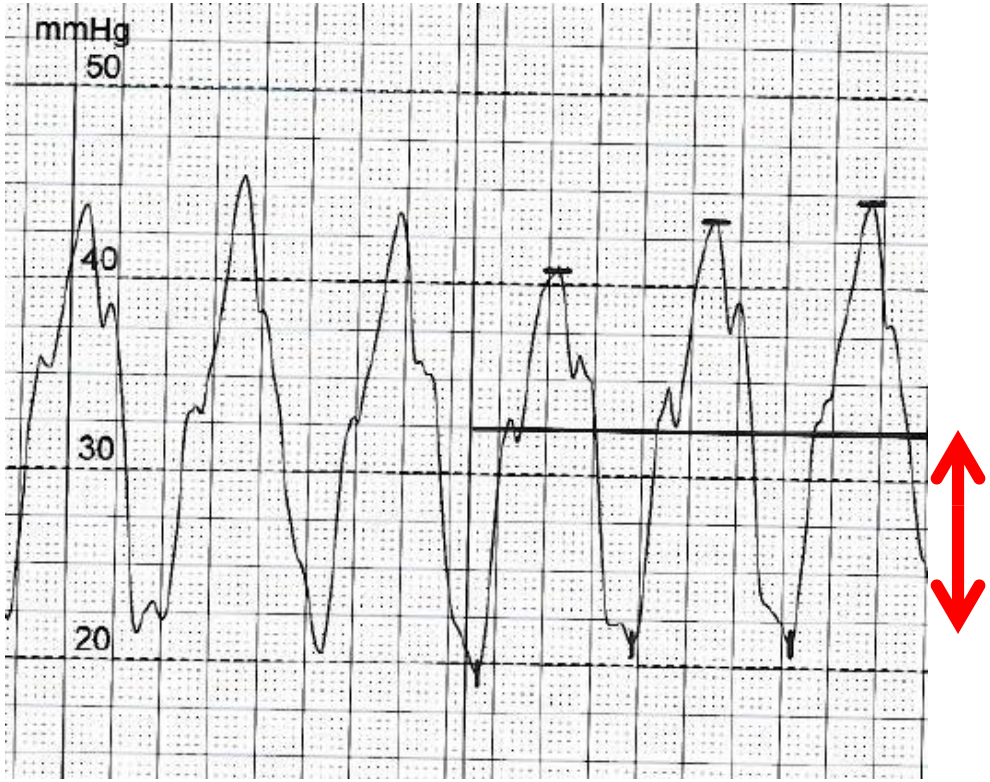


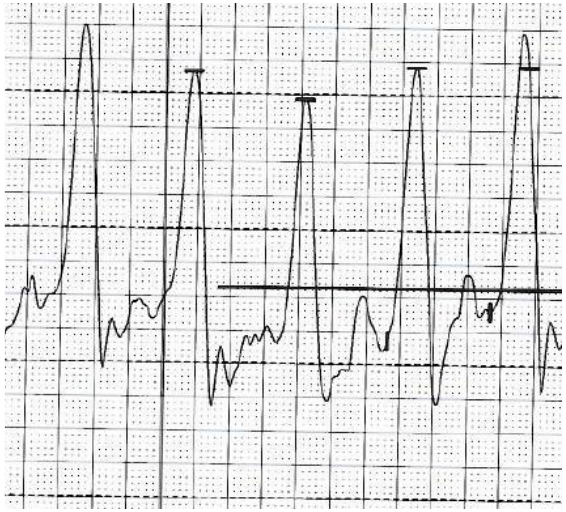
TPG=mPAP-mPAWP

PVR= TPG/cardiac output

mPAP

mPAWP↑

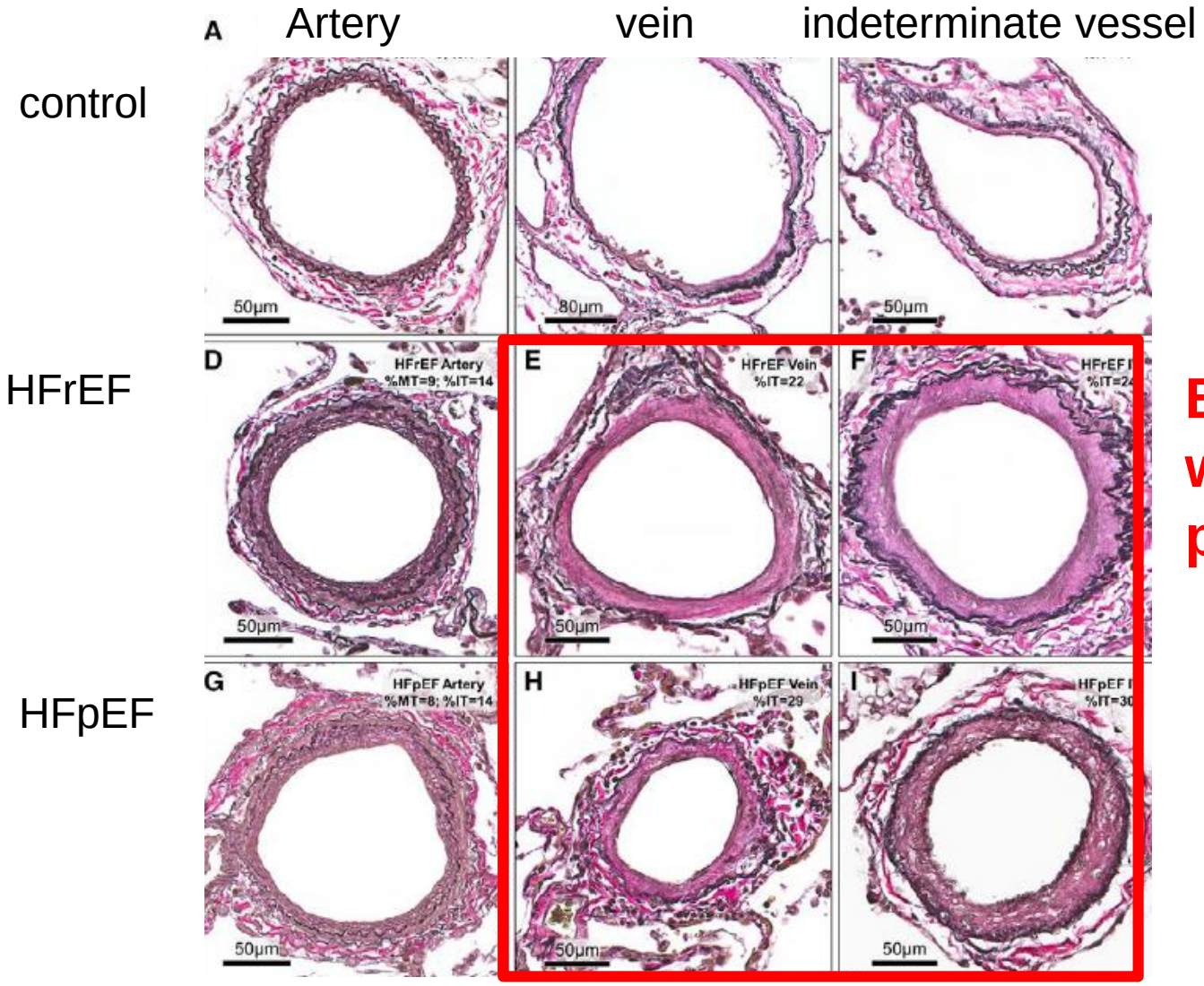




But TPG and PVR also↑

Combined pre- and post-capillary PH

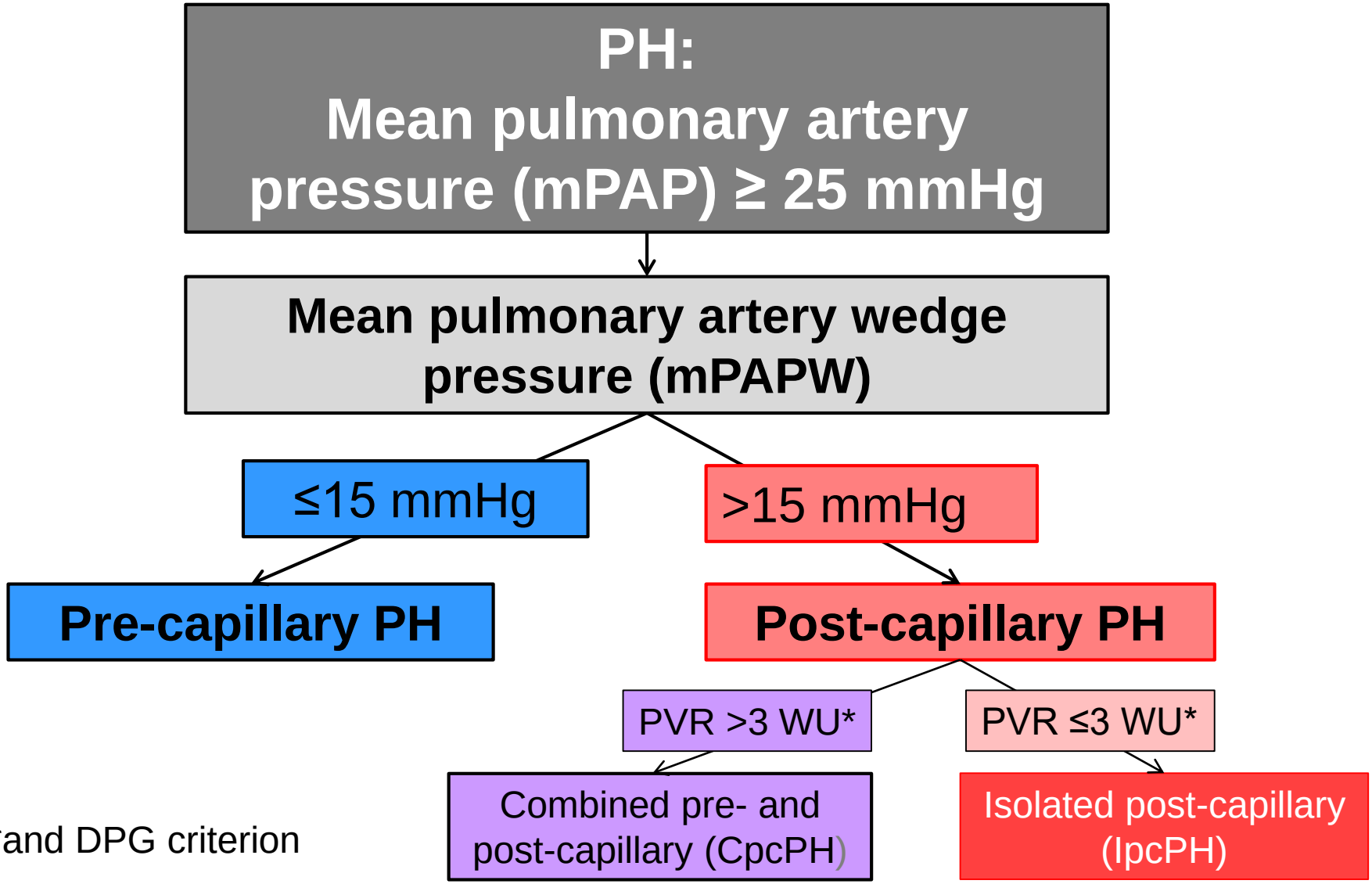
Pulmonary vascular remodeling in HFpEF-CpcPH



Best correlation with PA pressure

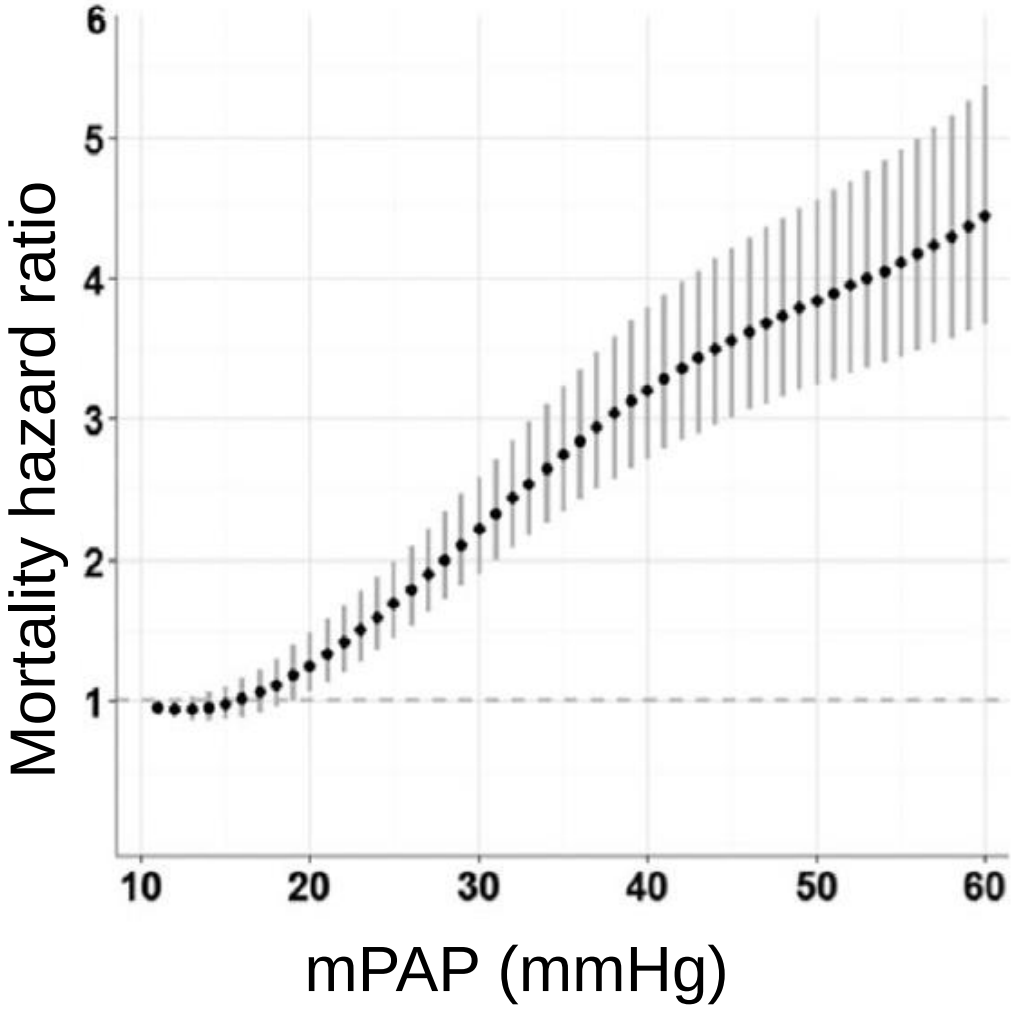
Fayyaz AU et al. Circulation 2018

PH Definition 2015



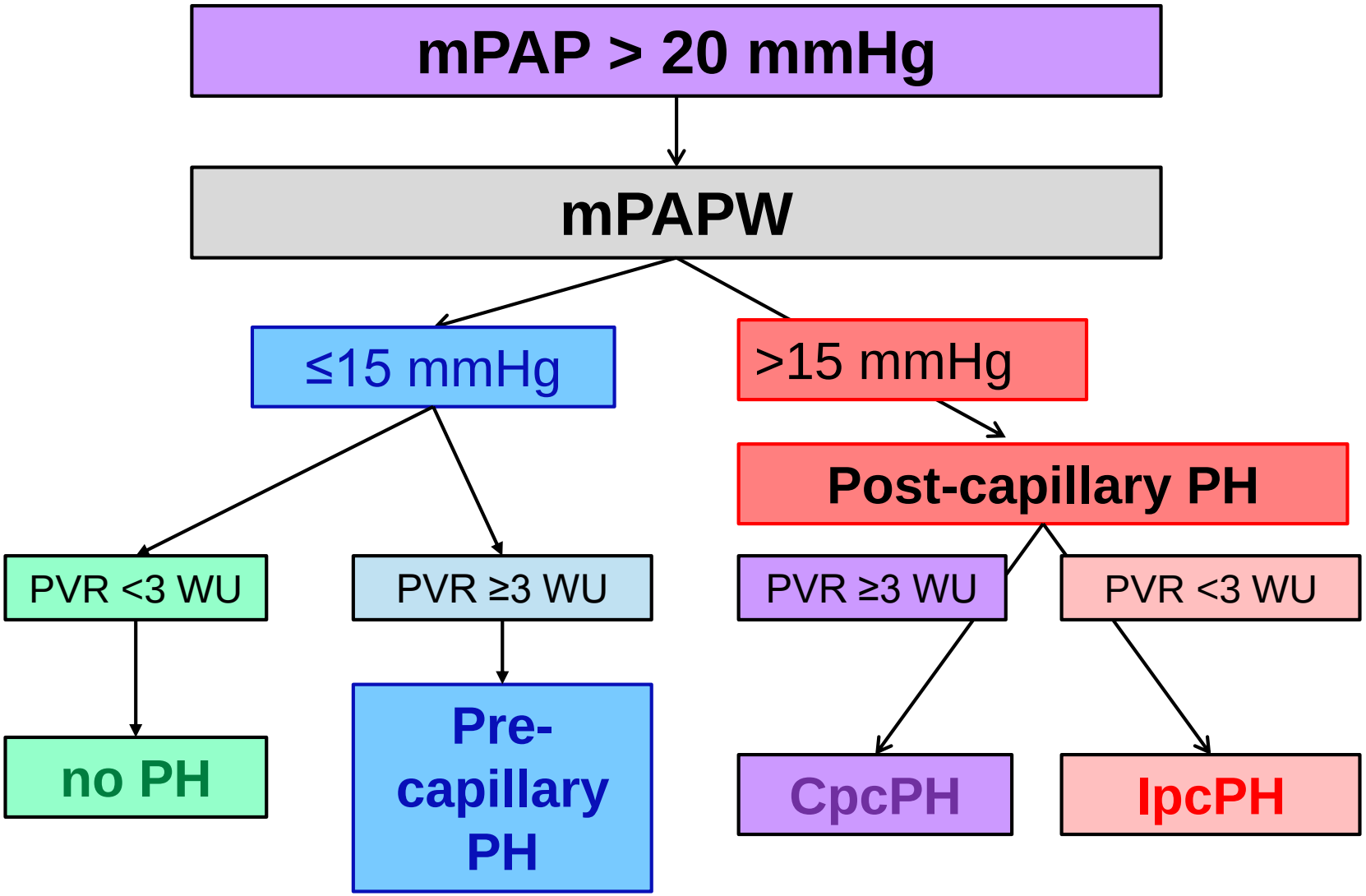
*and DPG criterion

Pulmonary pressure and prognosis

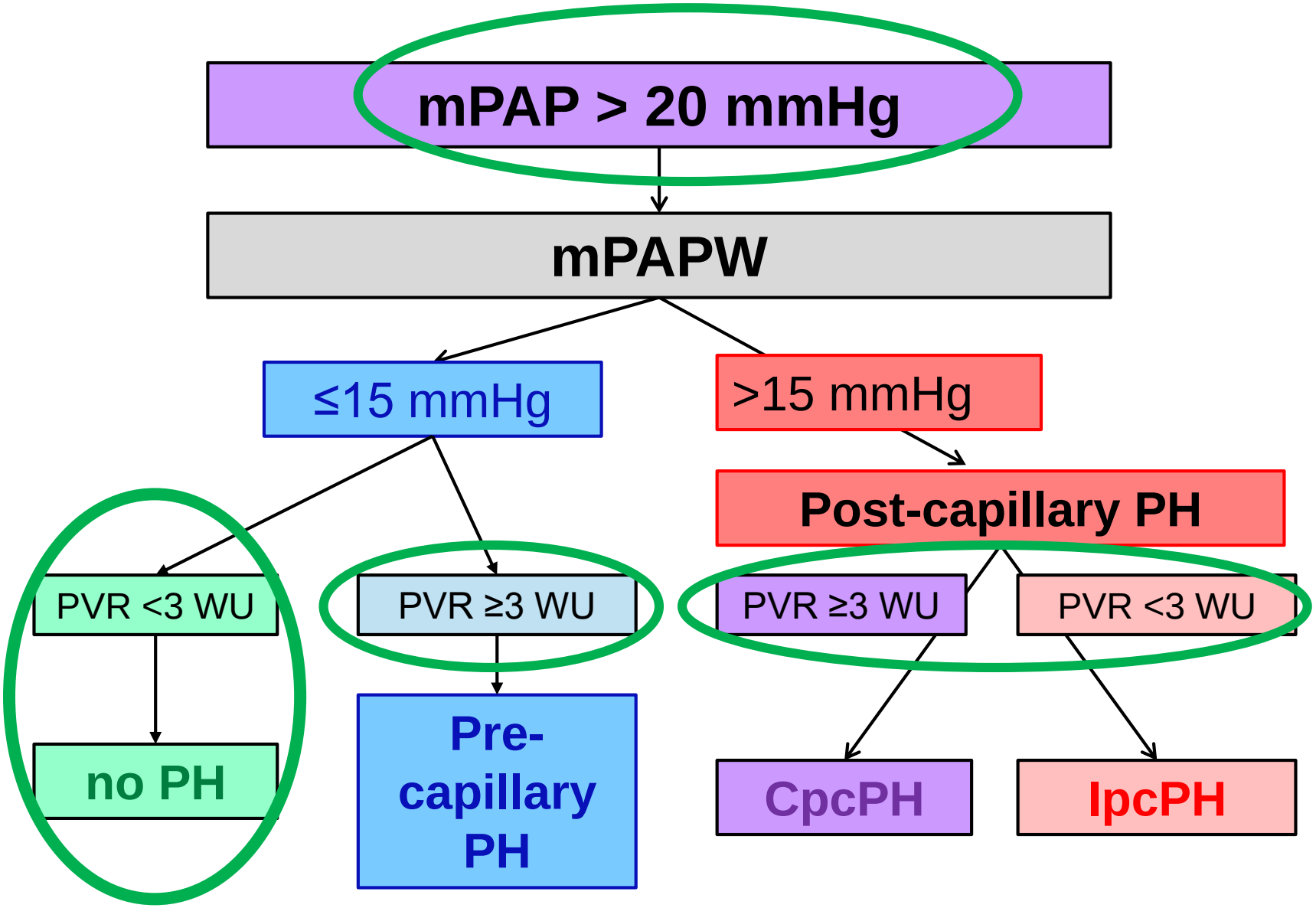


Maron B et al. Circulation 2016

PH Definition 2018



PH Definition 2018



ESC European Society of Cardiology
European Heart Journal (2022) 00, 1–114
https://doi.org/10.1093/eurheartj/ehac237

ESC/ERS GUIDELINES

2022 ESC/ERS Guidelines for the diagnosis and treatment of pulmonary hypertension

Developed by the task force for the diagnosis and treatment of pulmonary hypertension of the European Society of Cardiology (ESC) and the European Respiratory Society (ERS).

Endorsed by the International Society for Heart and Lung Transplantation (ISHLT) and the European Reference Network on rare respiratory diseases (ERN-LUNG).

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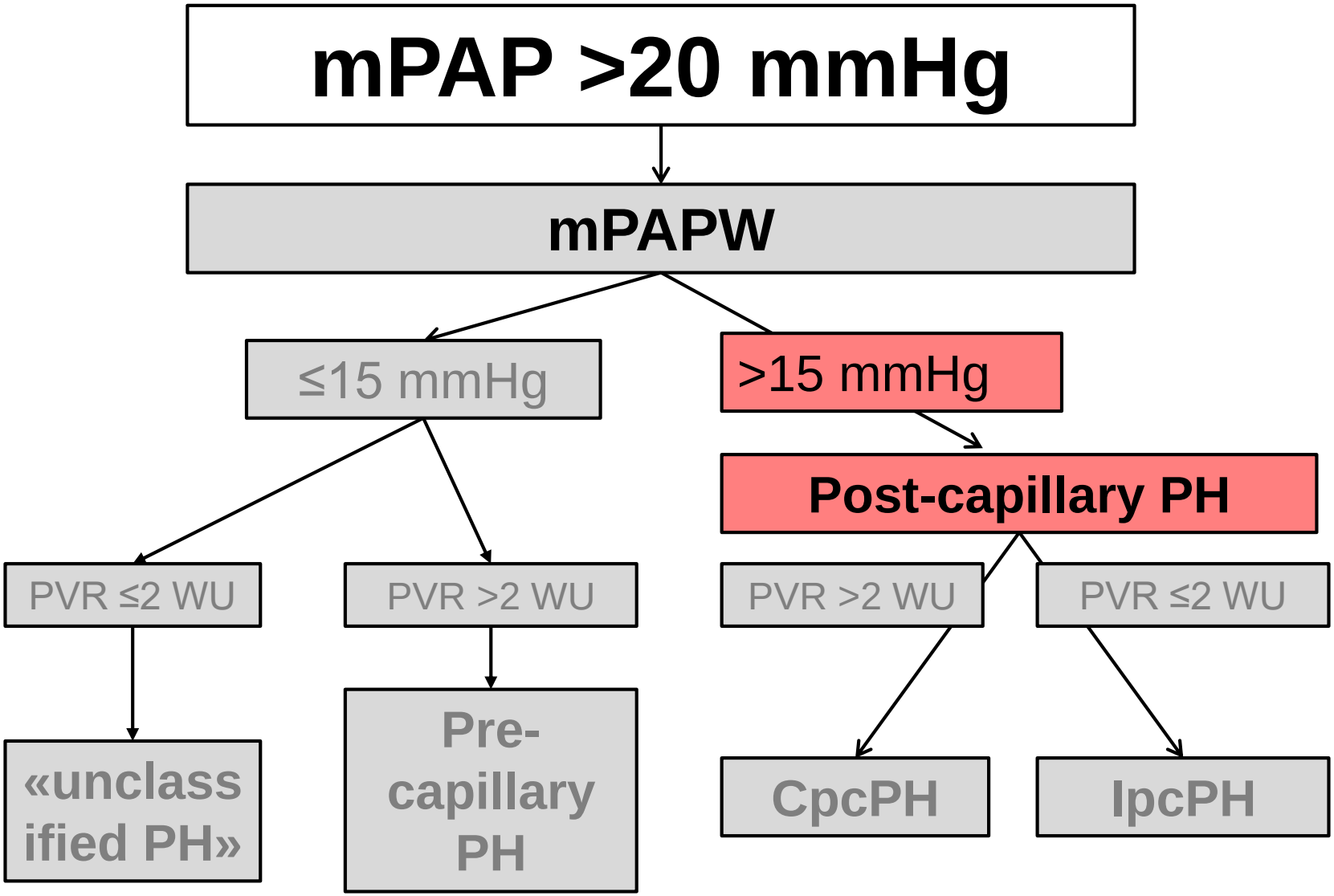
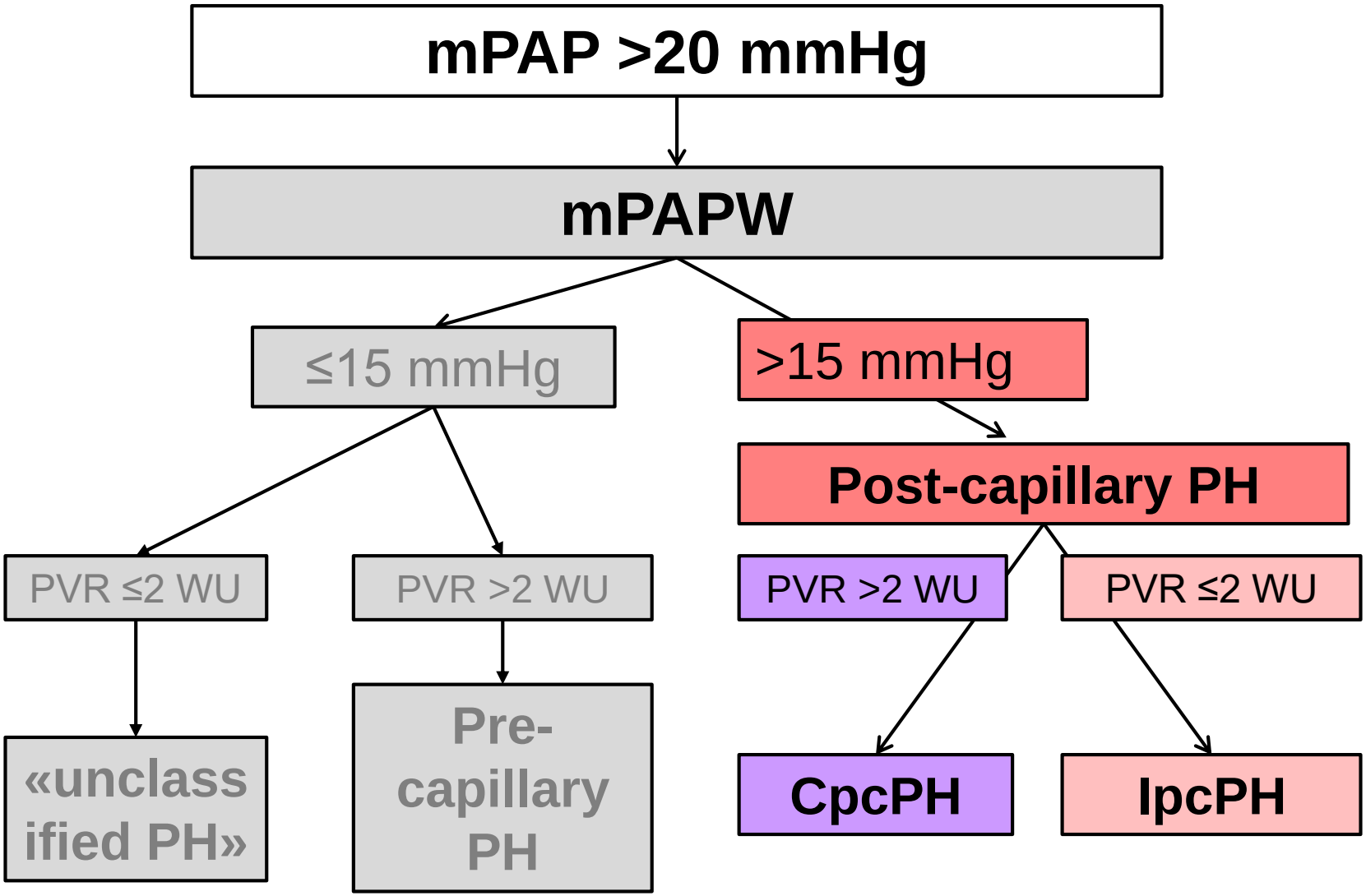
Eur Heart J 2022

PH Definition 2022



PH Definition 2022

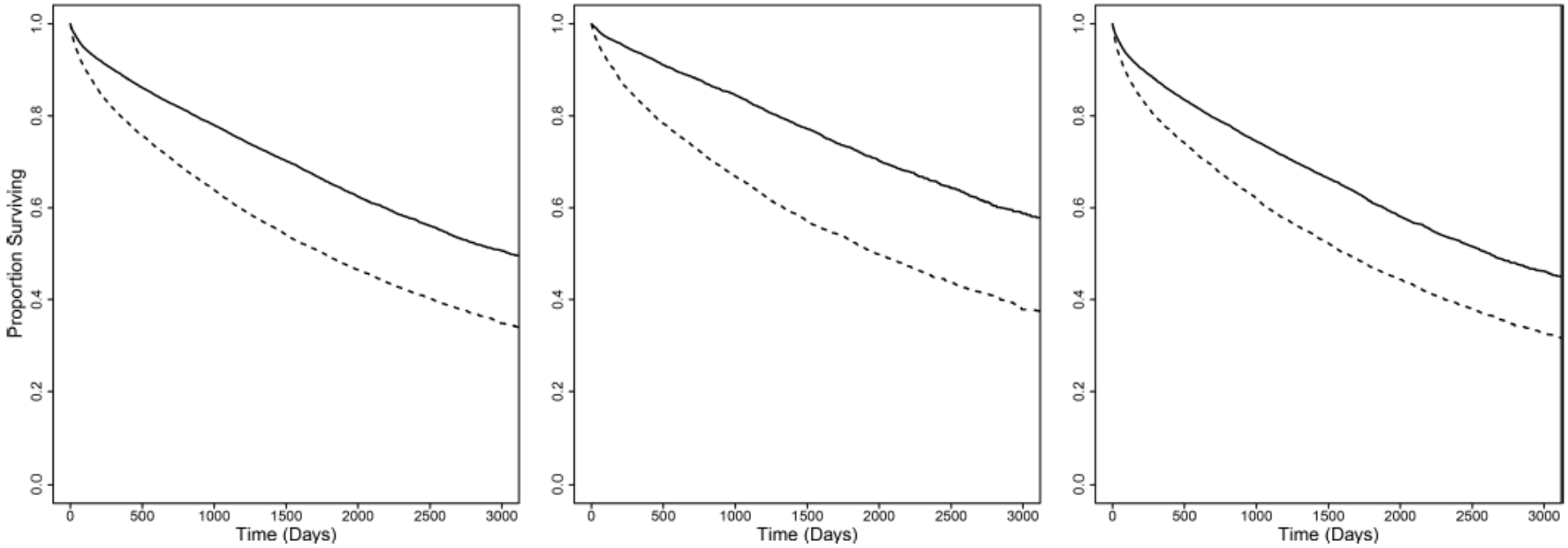


PVR and Mortality in an Unselected RHC Cohort

mPAP ≥19 mmHg

mPAP ≥19 mmHg
mPAWP ≤15 mmHg

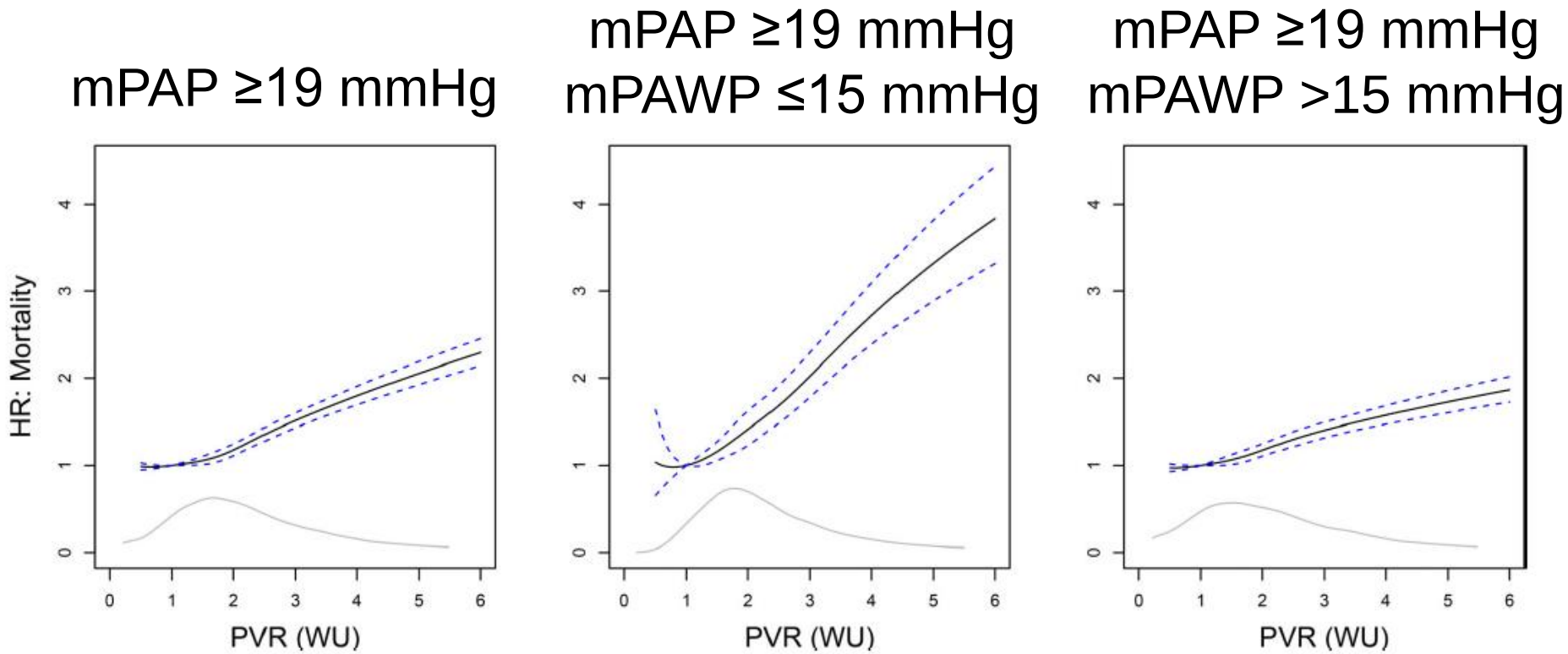
mPAP ≥19 mmHg
mPAWP >15 mmHg



PVR <2.2 WU
PVR ≥2.2 WU

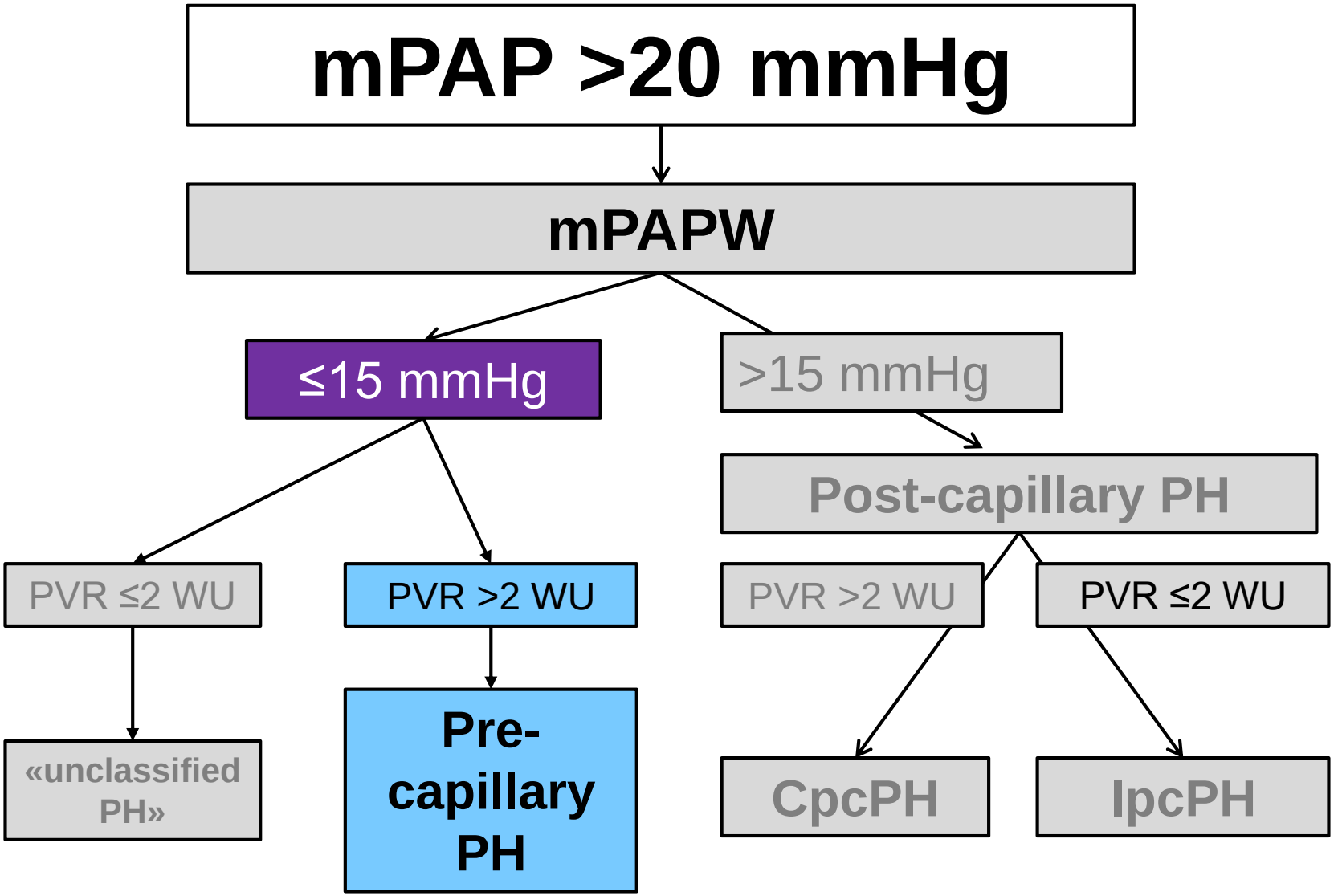
Maron B et al. Lancet Respir Med 2021

PVR and Mortality in an Unselected RHC Cohort

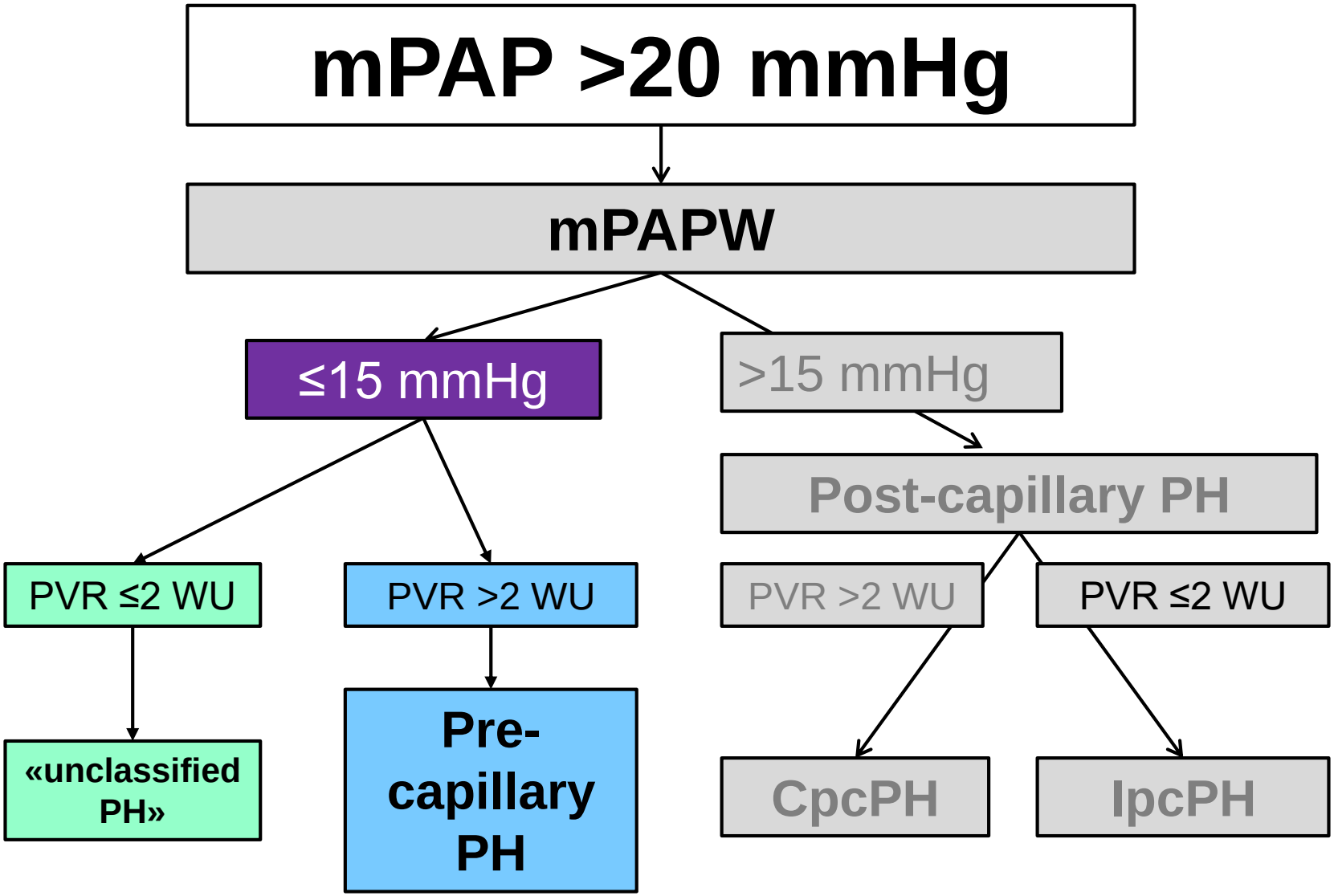


Maron B et al. Lancet Respir Med 2021

PH Definition 2022



PH Definition 2022



	mPAP ≥25 mmHg					
	mPAWP >15 mmHg			mPAWP ≤15 mmHg		
	PVR ≥3 WU	PVR <3 and >2 WU	PVR ≤2 WU	PVR ≥3 WU	PVR <3 and >2 WU	PVR ≤2 WU
2015[2 a]	CpcPH	IpcPH	IpcPH	praecPH[b,c]	praecPH[b]	praecPH[b,d]
2018[3]	CpcPH	IpcPH	IpcPH	praecPH[c]	Unclassified PH[e]	Unclassified PH[d,e]
2022[4]	CpcPH	CpcPH	IpcPH	praecPH[c]	praecPH[c]	Unclassified PH[d]
	mPAP 21-24 mmHg					
	mPAWP >15 mmHg			mPAWP ≤15 mmHg		
	PVR ≥3 WU	PVR <3 and >2 WU	PVR ≤2 WU	PVR ≥3 WU	PVR <3 and >2 WU	PVR ≤2 WU
2015[2a]	No PH	No PH	No PH	No PH	No PH	No PH
2018[3]	CpcPH	IpcPH	IpcPH	praecPH[c]	Unclassified PH[e]	Unclassified PH[e]
2022[4]	CpcPH	CpcPH	IpcPH	praecPH[c]	praecPH[c]	Unclassified PH

Figure 1 Illustration of the impact of the different pulmonary hypertension definitions on the classification of different haemodynamic constellations. CpcPH, combined prae-capillary and post-capillary pulmonary hypertension; IpcPH, isolated post-capillary pulmonary hypertension; mPAP, mean pulmonary artery pressure; mPAWP, mean pulmonary artery wedge pressure; praecPH, prae-capillary pulmonary hypertension; PH: pulmonary hypertension; PVR, pulmonary vascular resistance, WU, Wood units. [a]For simplification, the diastolic pressure gradient criterion is not considered (as this has been done in several clinical studies). In addition, the PVR criterion in the 2015 definition was '>3 WU'; for simplification, this was considered equivalent to '≥3 WU'. [b]According to the 2015 definition, there is no explicit PVR criterion for the definition of praecPH. [c]In case of a borderline mPAWP of 13–15 mm Hg in combination with features suggestive of post-capillary PH (typically left atrial dilatation), 'occult CpcPH' is likely, and unmasking by provocative testing (volume challenge, exercise) has to be considered. [d]In patients with mPAP ≥25 mm Hg and mPAWP ≤15 mm Hg, the transpulmonary gradient is at least 10 mm Hg, and in the presence of a normal or reduced cardiac output, the PVR will be at least 2 WU. Thus, this constellation is unlikely to be found in clinical practice except for patients with high cardiac output. [e]This constellation was not officially defined in the 2018 definition but in keeping with 2022 definition the term 'unclassified PH' is also used for the 2018 definition.

Maeder MT. Heart 2023

	mPAP ≥25 mmHg					
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2015[2a]	No PH	No PH	No PH	No PH	No PH	No PH
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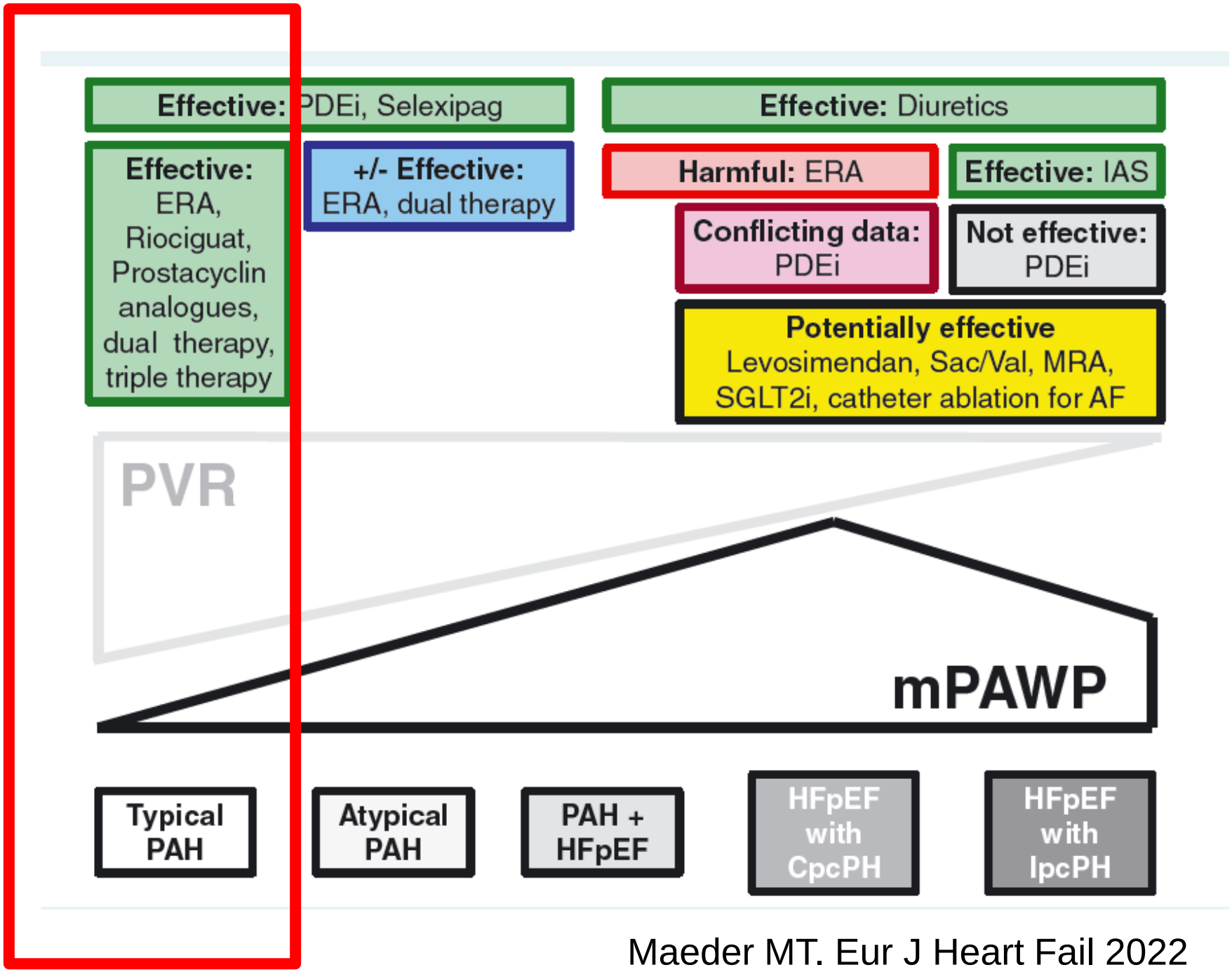
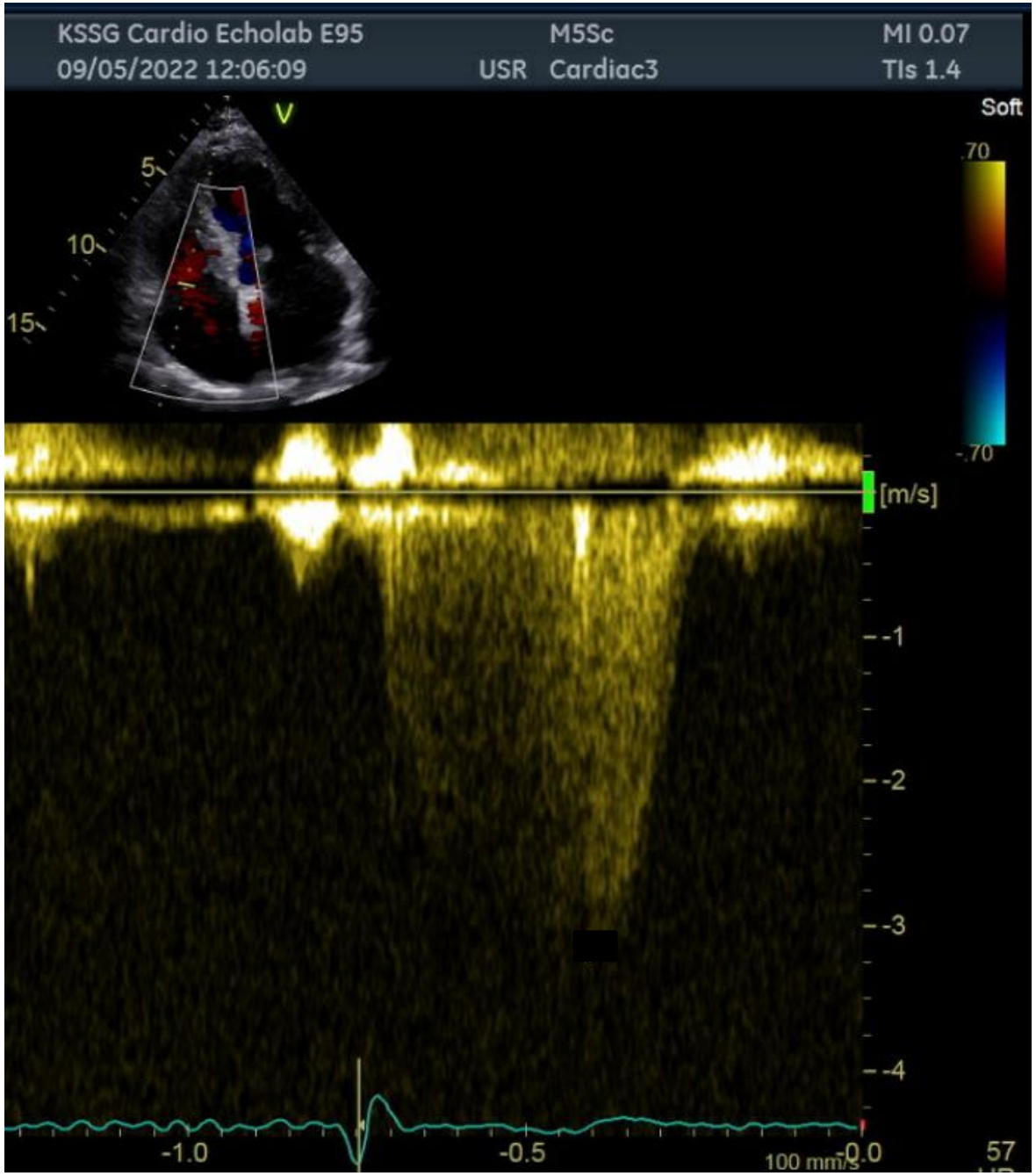
Maeder MT. Heart 2023

2015[2a]	
2018[3]	
2022[4]	

mPAP 21-24 mmHg		
	mPAWP >15 mmHg	
	PVR <3 and >2 WU	
	No PH	
	IpcPH	
	CpcPH	

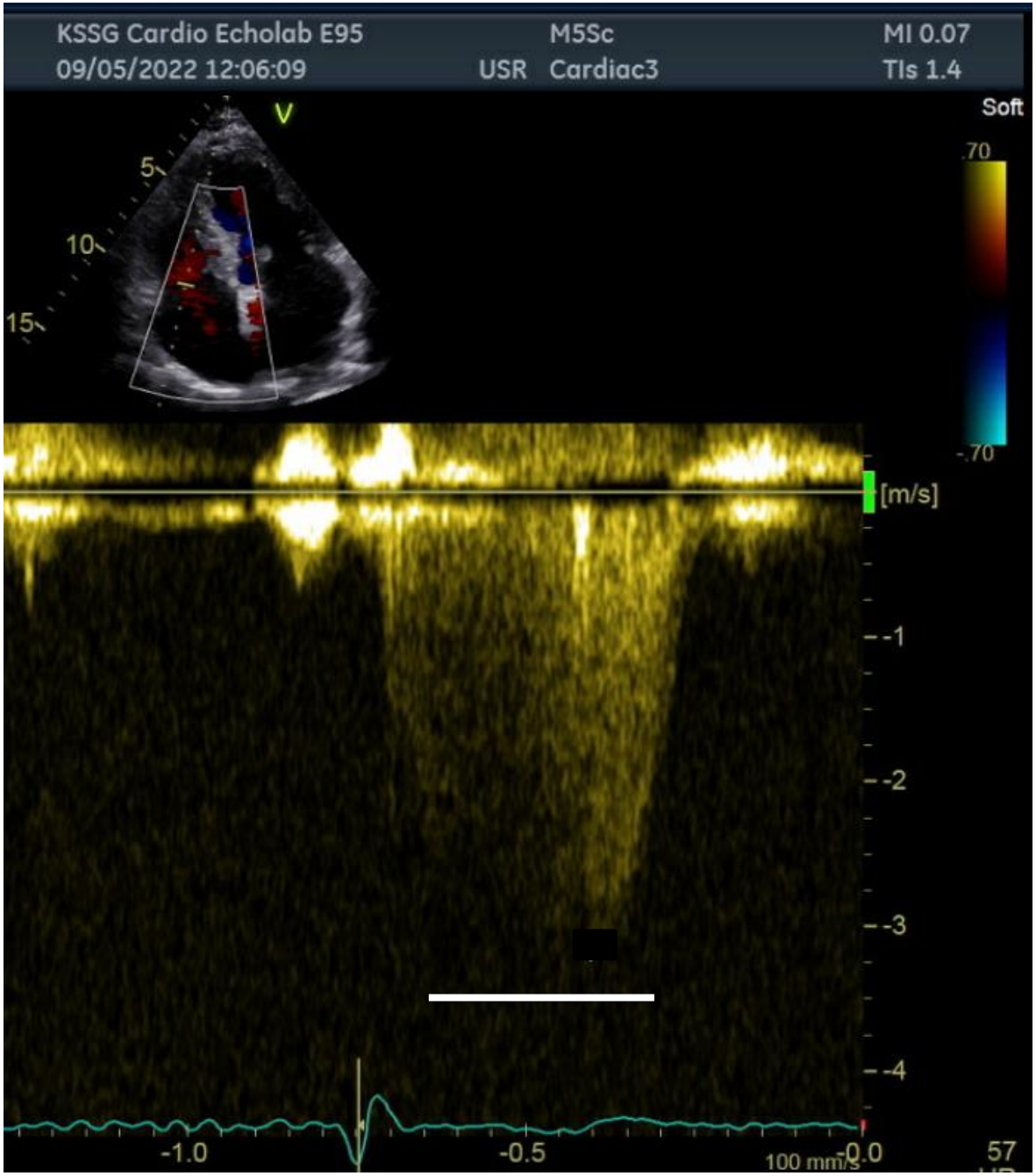


Maeder MT. Eur J Heart Fail 2022



Pulmonary Hypertension?

Pulmonary arterial hypertension?



sPAP
=4 x peakTRV^2
+CVP
=4 x (3.5)^2 +10
=59 mmHg

← 3.5 m/s

Low PH probability

- TRV **≤2.8 m/s** (sPAP ≤36 mmHg) or not measurable **AND NO** indirect signs of PH

Intermediate PH probability

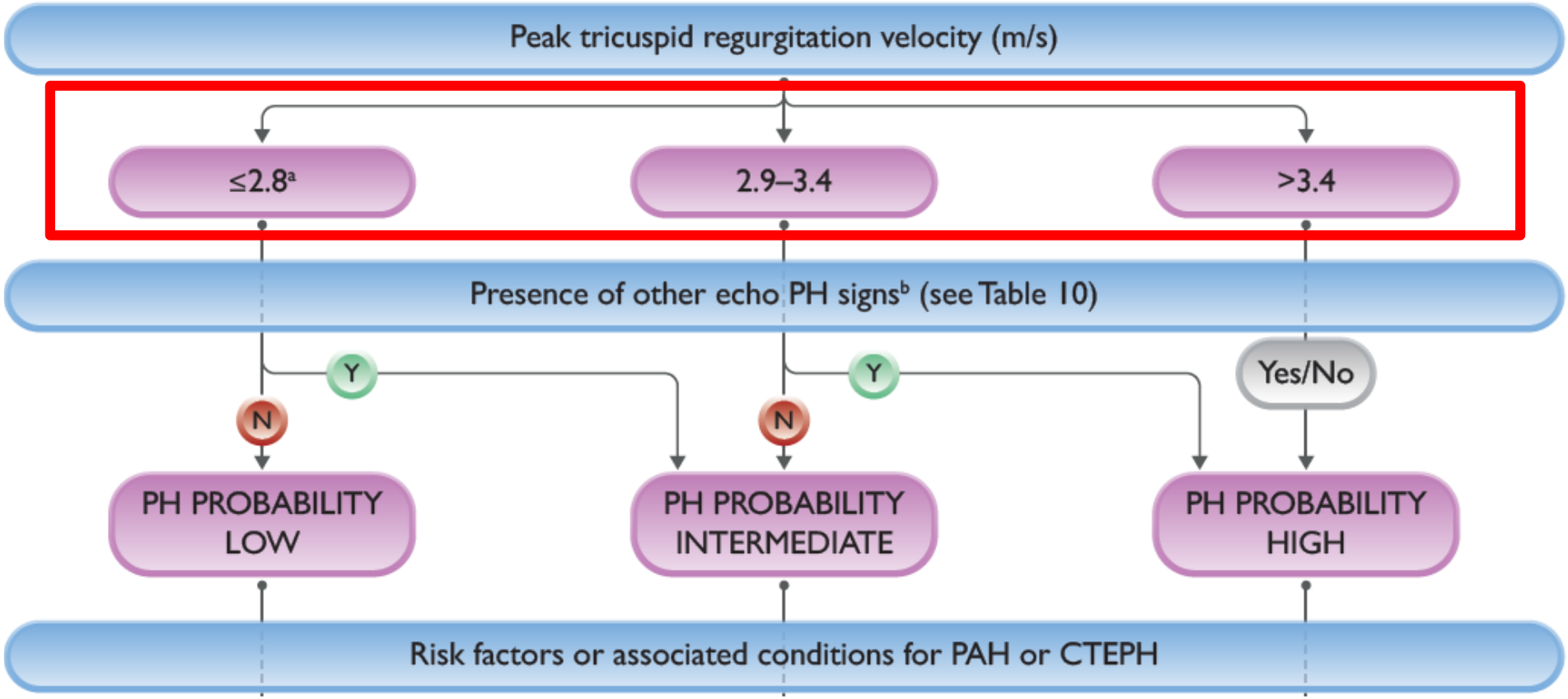
- TRV **≤2.8 m/s** (sPAP ≤36 mmHg) **AND indirect** signs of PH
- **TRV 2.9-3.4 m/s** (sPAP 37-50 mmHg) **AND NO** indirect signs of PH

High PH probability

- **TRV 2.9-3.4 m/s** (sPAP 37-50 mmHg) **AND indirect** signs of PH
- **TRV >3.4 m/s** (sPAP >50 mmHg) **WITH/WITHOUT** indirect signs of PH

Galie N et al. Eur Heart J 2015

2022: re-calibration needed? - No



Humbert M et al. Eur Heart J 2022

A: Ventricles	B: Pulmonary artery	C: IVC and RA
RV/LV basal diameter ratio >1	RVOT AT <105 ms and/or mid-systolic notching	IVC diameter >21 mm with decreased inspiratory collapse
«D-shape» of the LV (LVEI >1.1 in systole and/or diastole)	Early diastolic pulmonary regurgitation velocity >2.2 m/s	RA area >18 cm^2
TAPSE/sPAP ratio <0.55	PA diameter >AR diameter PA diameter >25 mm	

Humbert M et al. Eur Heart J 2022

A: Ventricles	B: Pulmonary artery	C: IVC and RA
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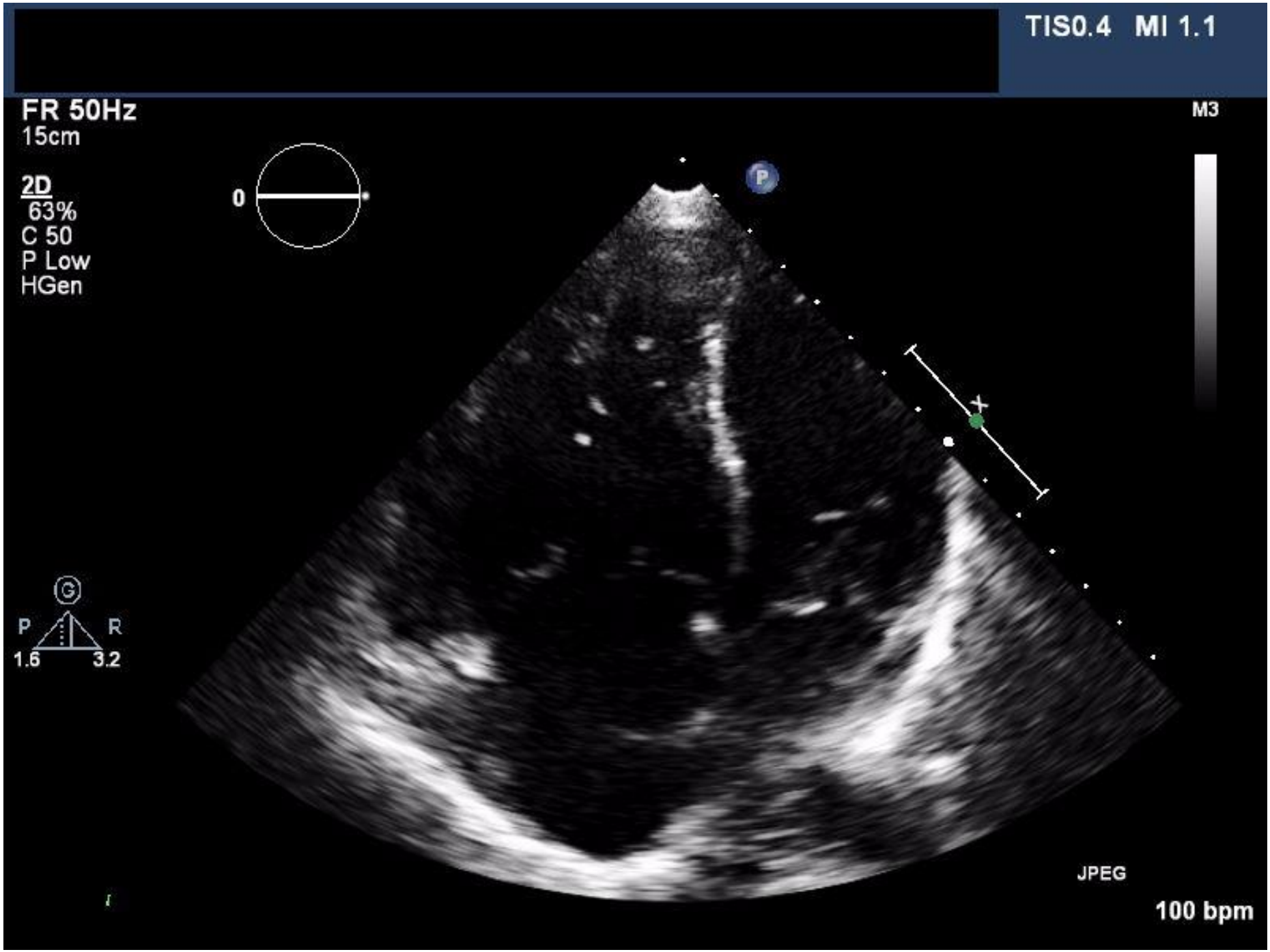
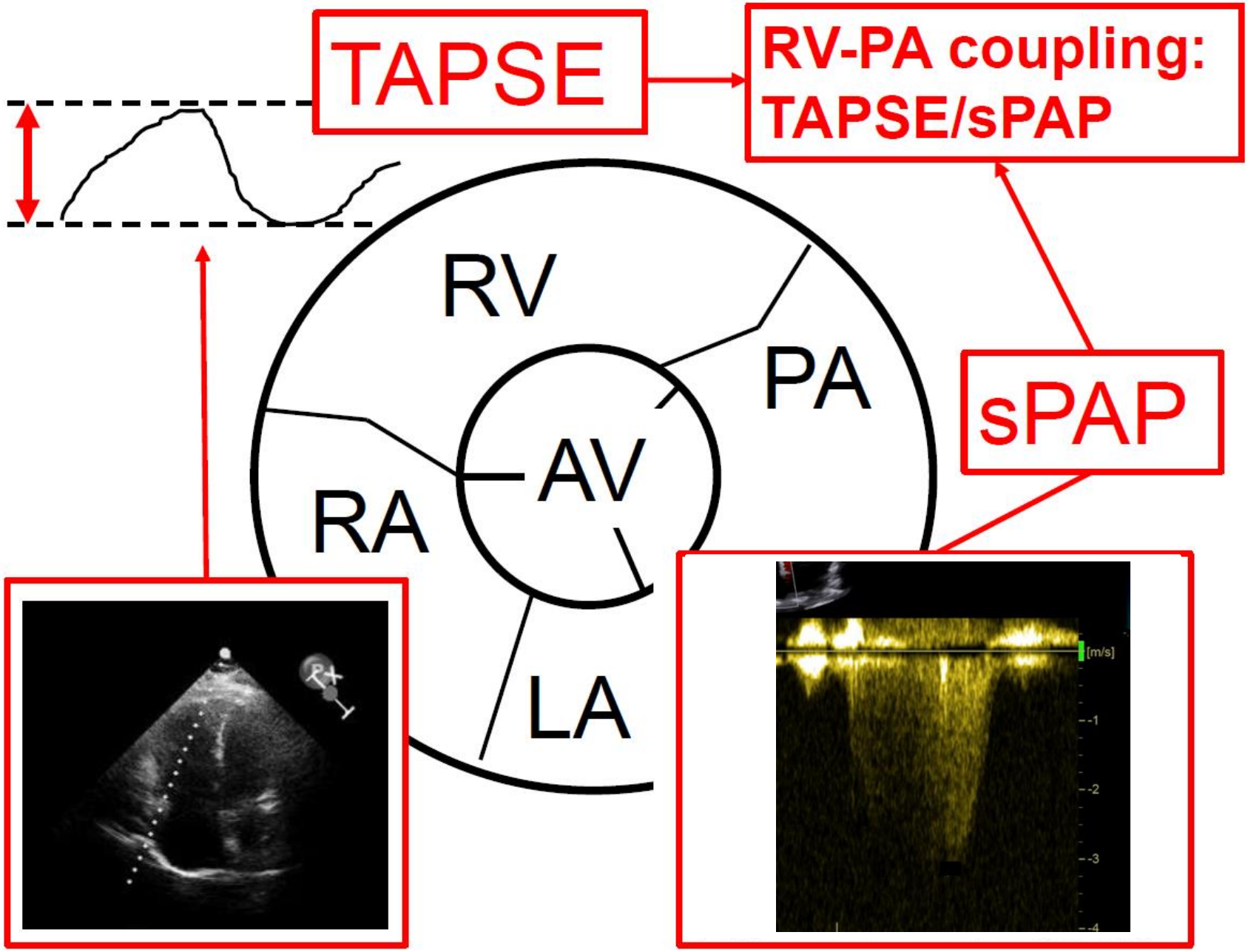
Humbert M et al. Eur Heart J 2022


TIS0.4 MI 1.1
FR 50Hz
15cm
2D
63%
C 50
P Low
HGen
0
M3
P
G
P
R
1.6
3.2
JPEG
100 bpm


z/3.3 MHz
dB
0 dB
5
10

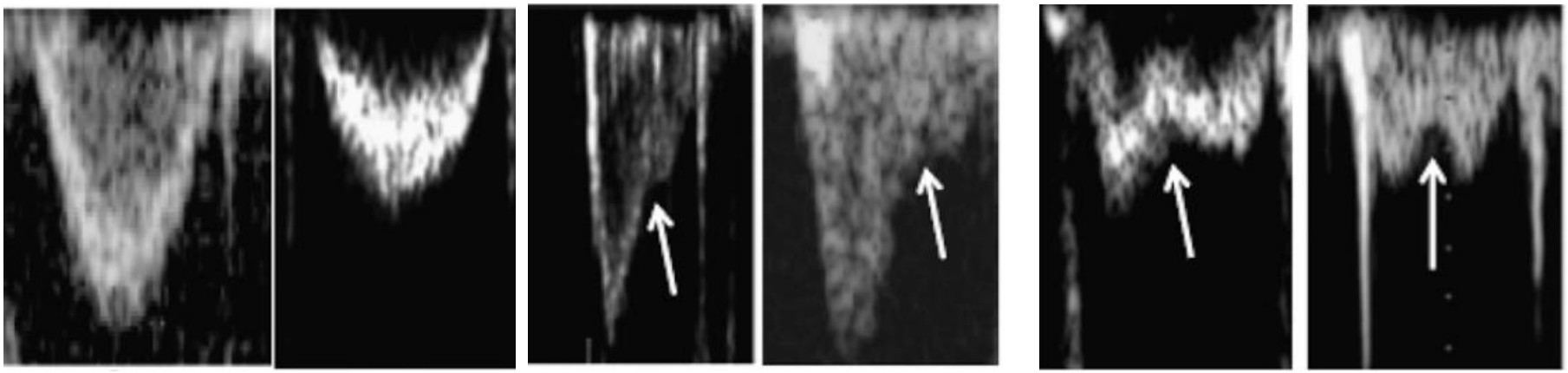

TAPSE
RV-PA coupling:
TAPSE/sPAP
RV
PA
AV
RA
LA
sPAP
[m/s]
-1
-2
-3
-4

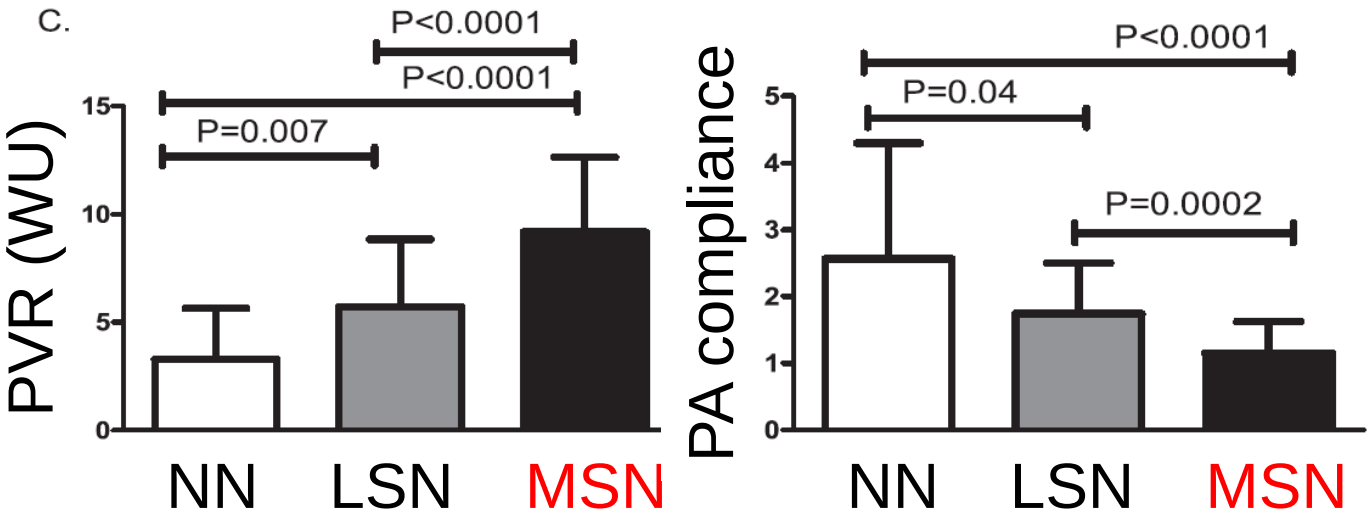
RVOT PW Doppler: «Notch»

Nn notch (NN)

Late-systolic notch (LSD)

mid-systolic notch (MSN)





Arkles JS et al. Am J Resp Crit Care Med 2011

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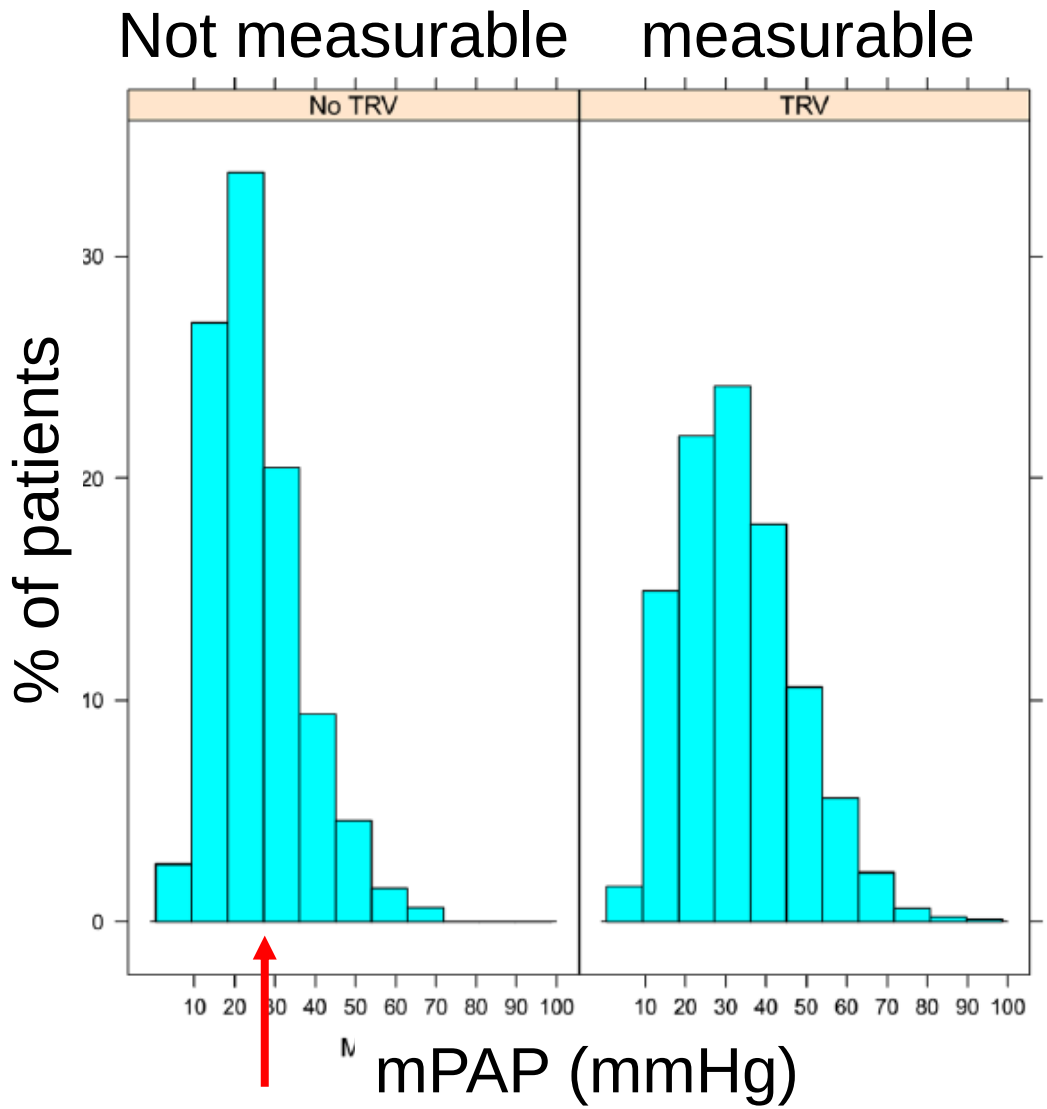
Galie N et al. Eur Heart J 2015

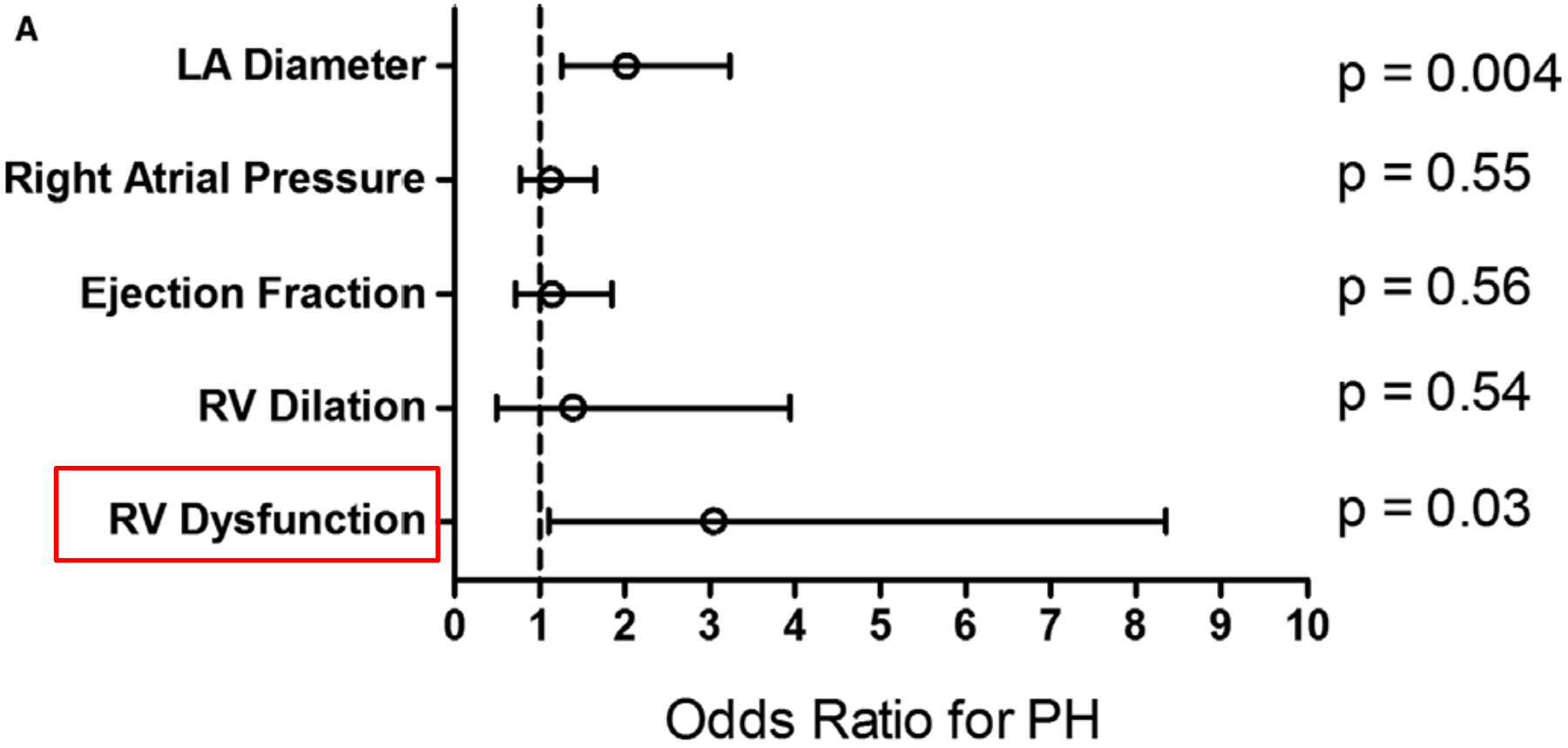
No TR signal: no PH?



25 mmHg

O'Leary JM et al. JAHA 2018

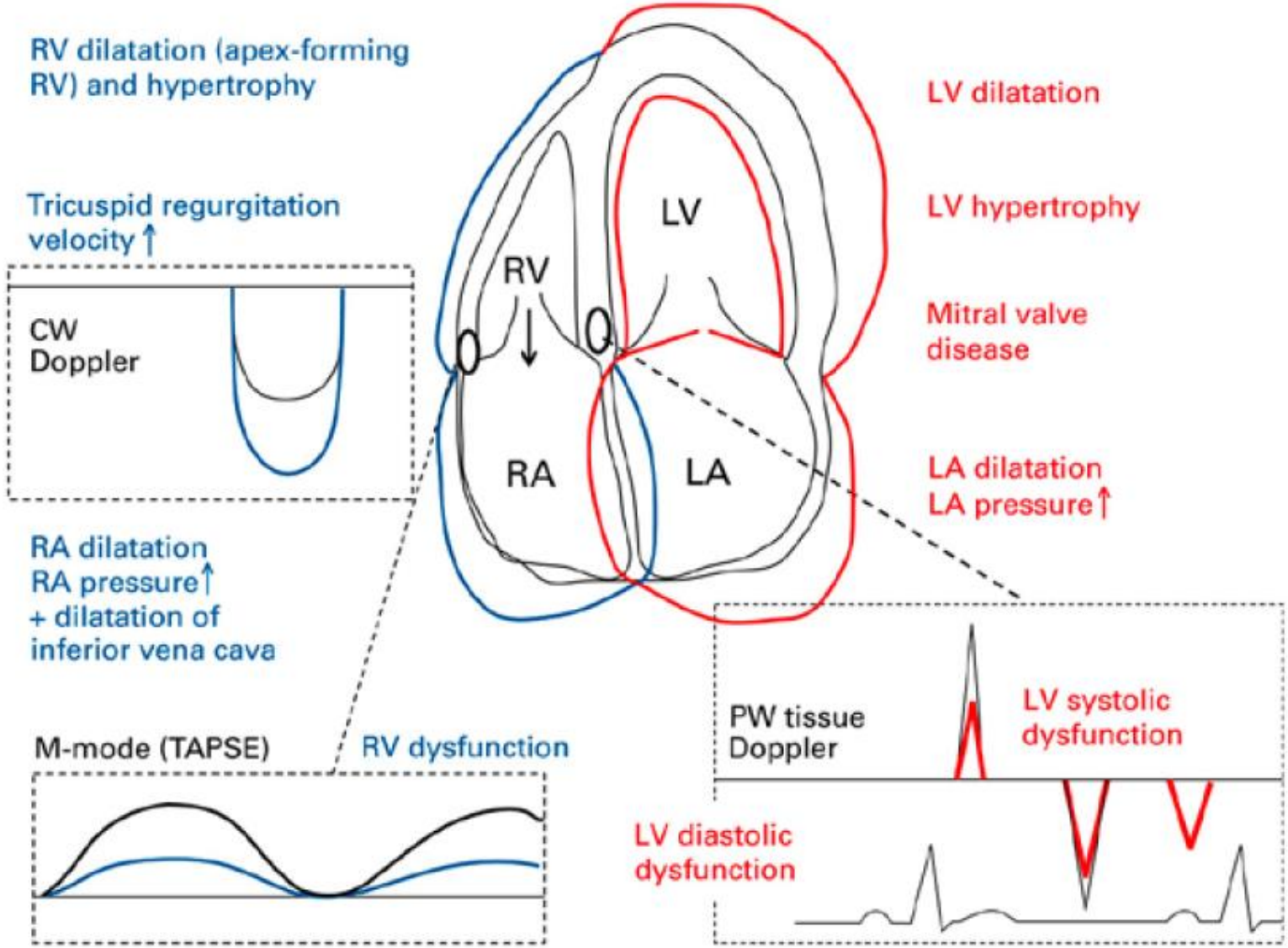
Predictors of PH in absence of a mesasurable TR signal



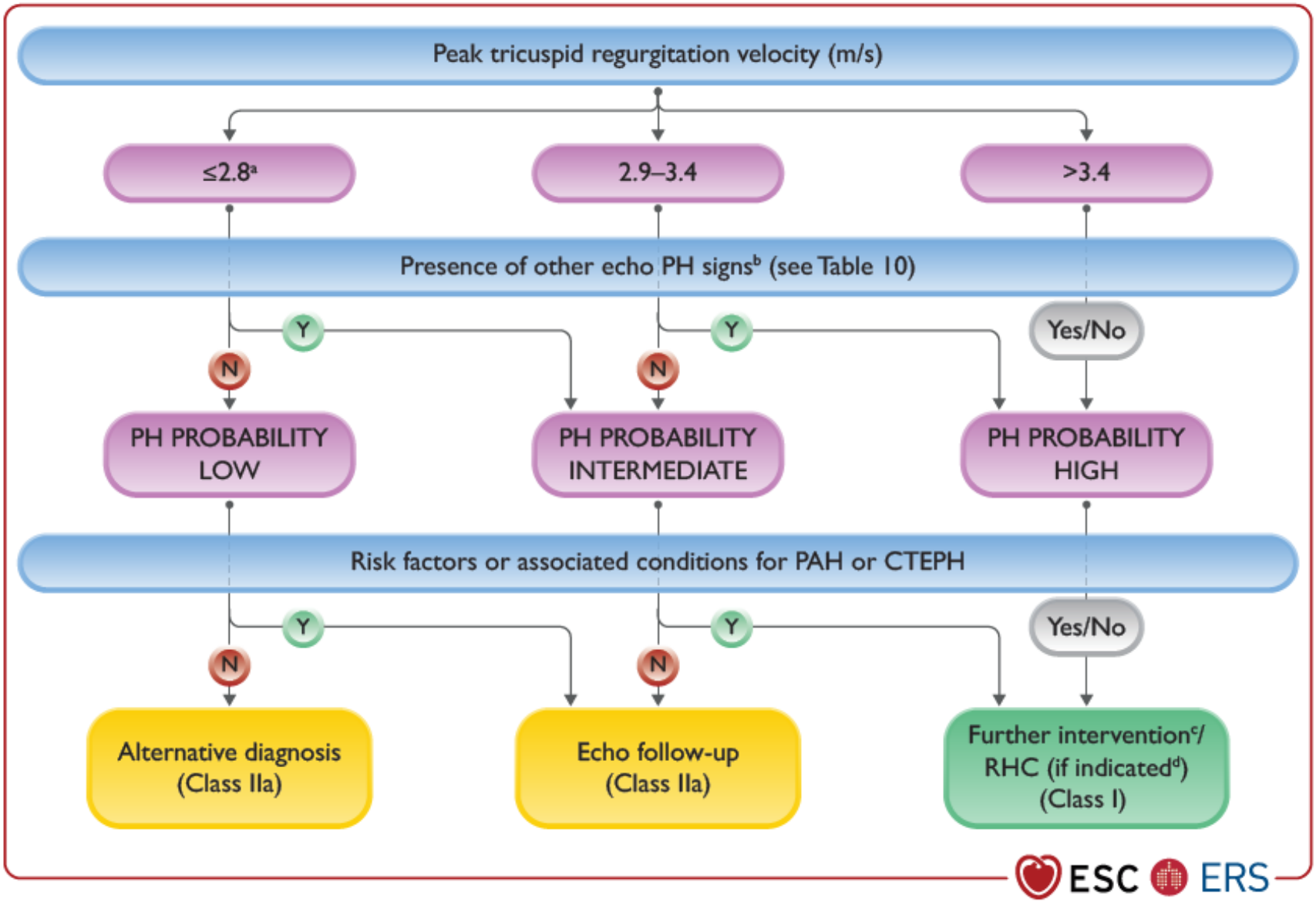
O'Leary JM et al. JAHA 2018

Favors pre-capillary

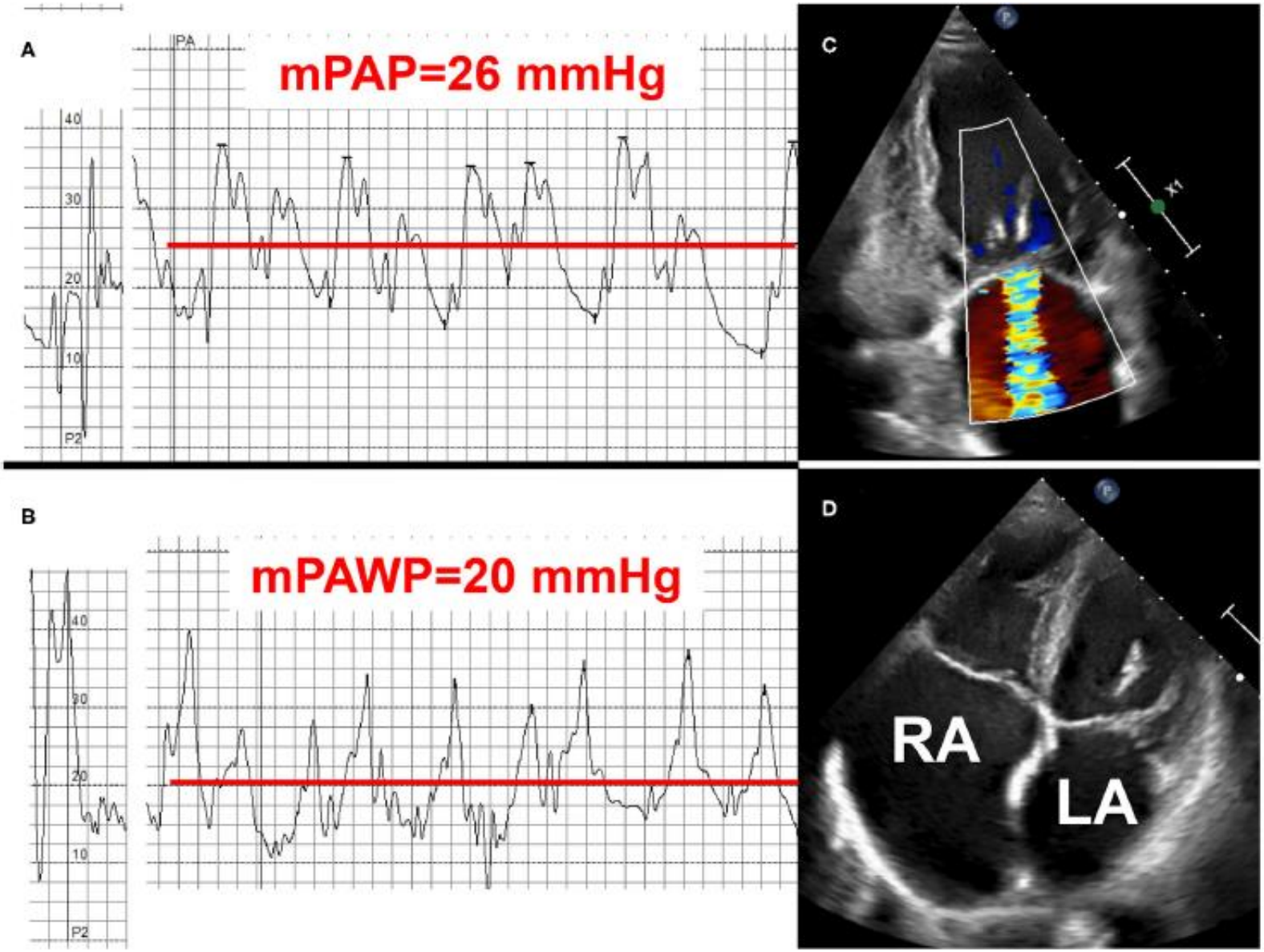
Favors post-capillary



Maeder MT et al. Swiss Med Wkly 2017

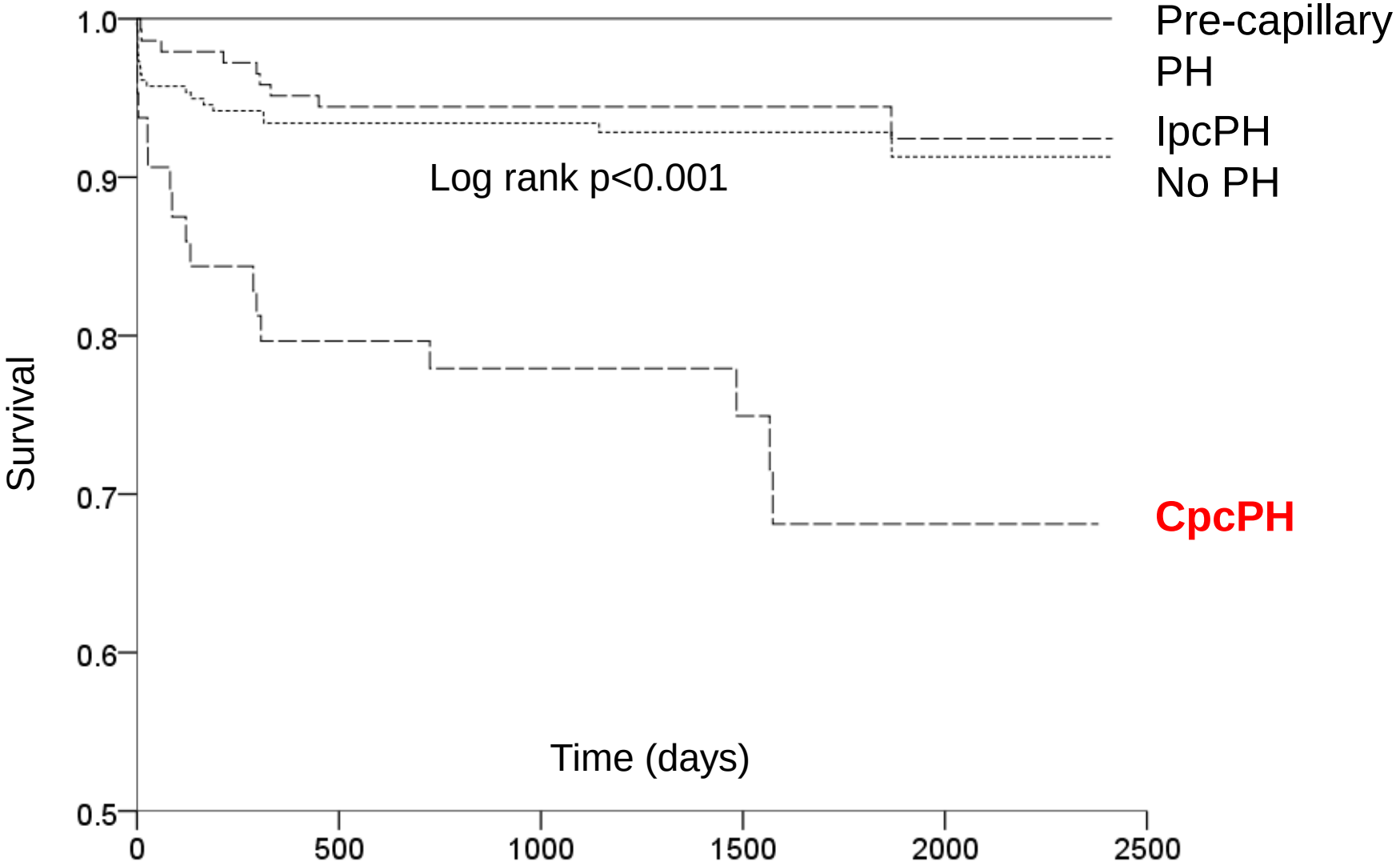


Humbert M et al. Eur Heart J 2022

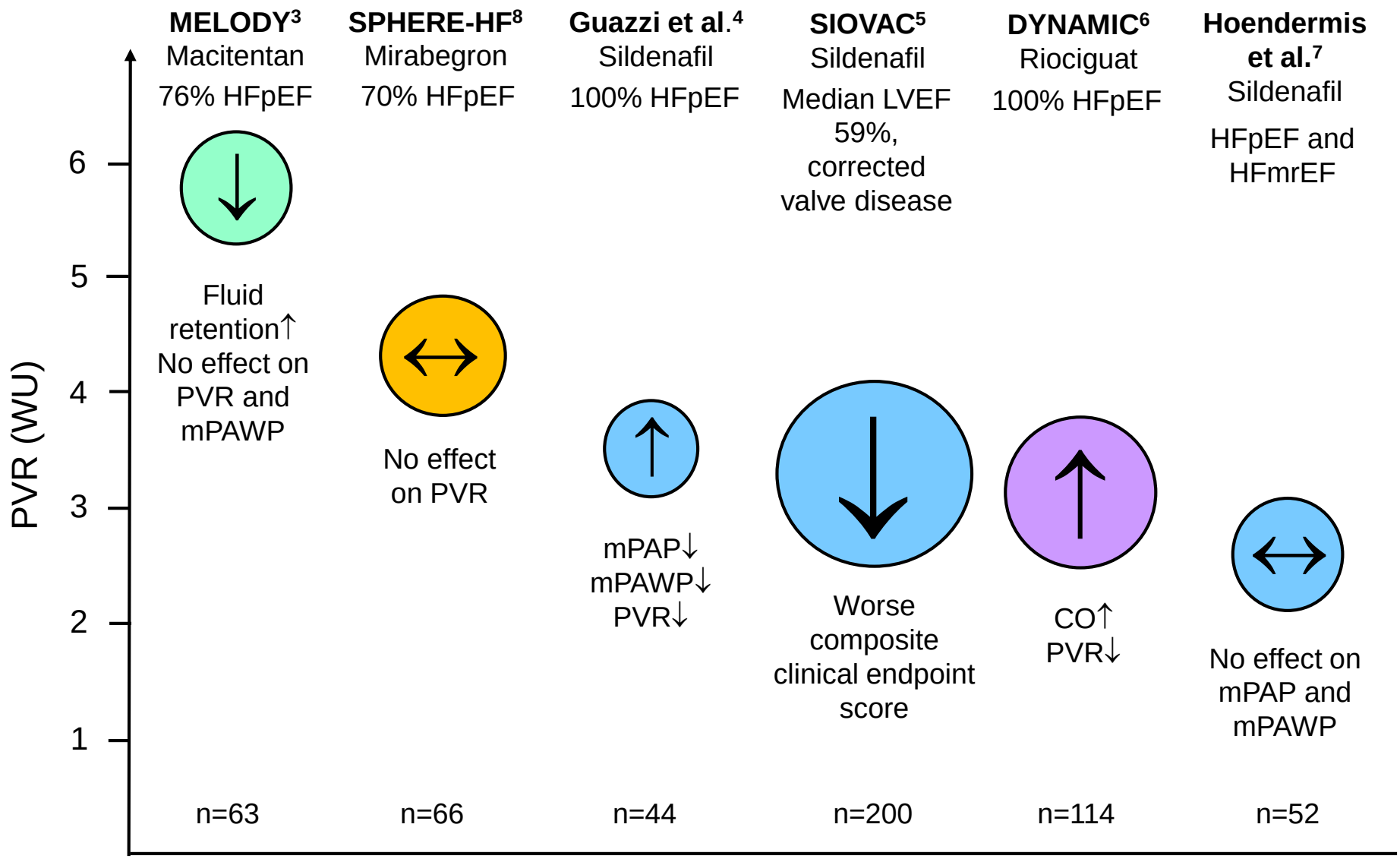


Maeder MT et al. Front Cardiovasc Med 2021

Pre-AVR CpcPH and long-term post-AVR mortality



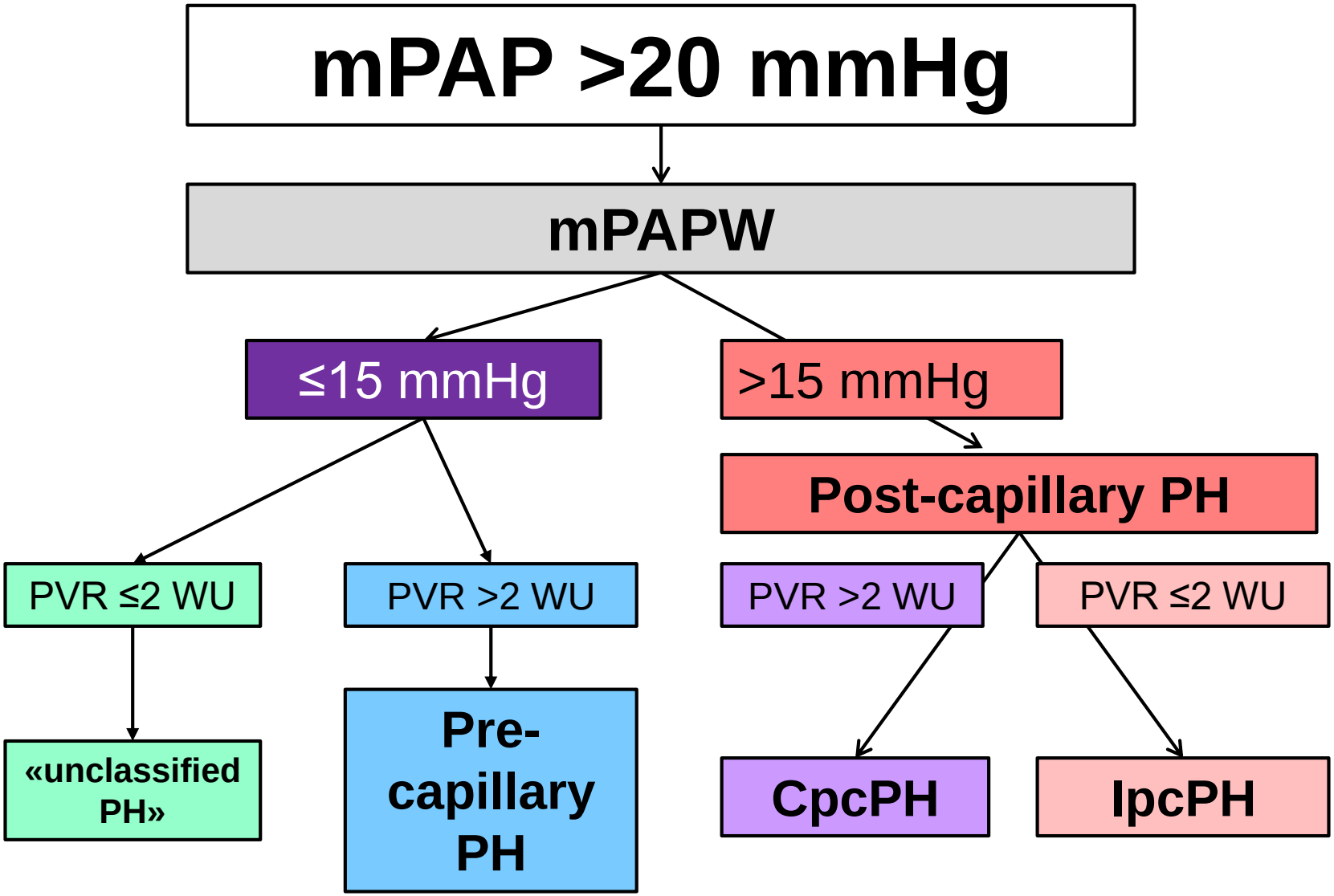
Weber L et al. Eur J Heart Heart Fail 2018

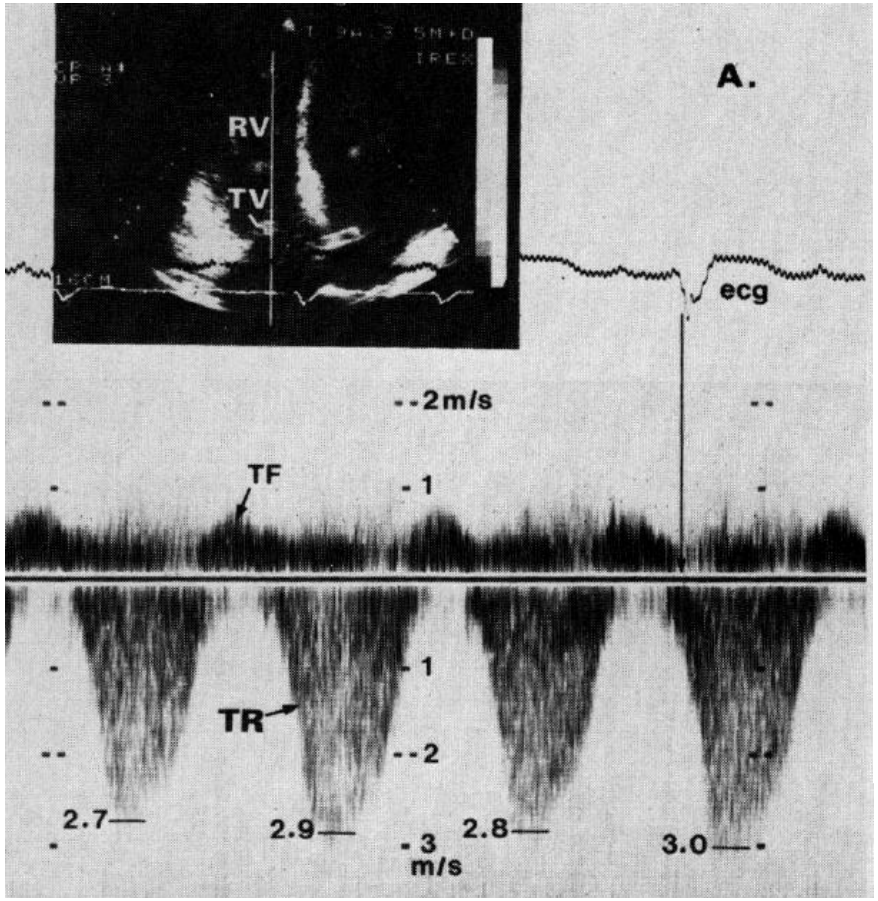


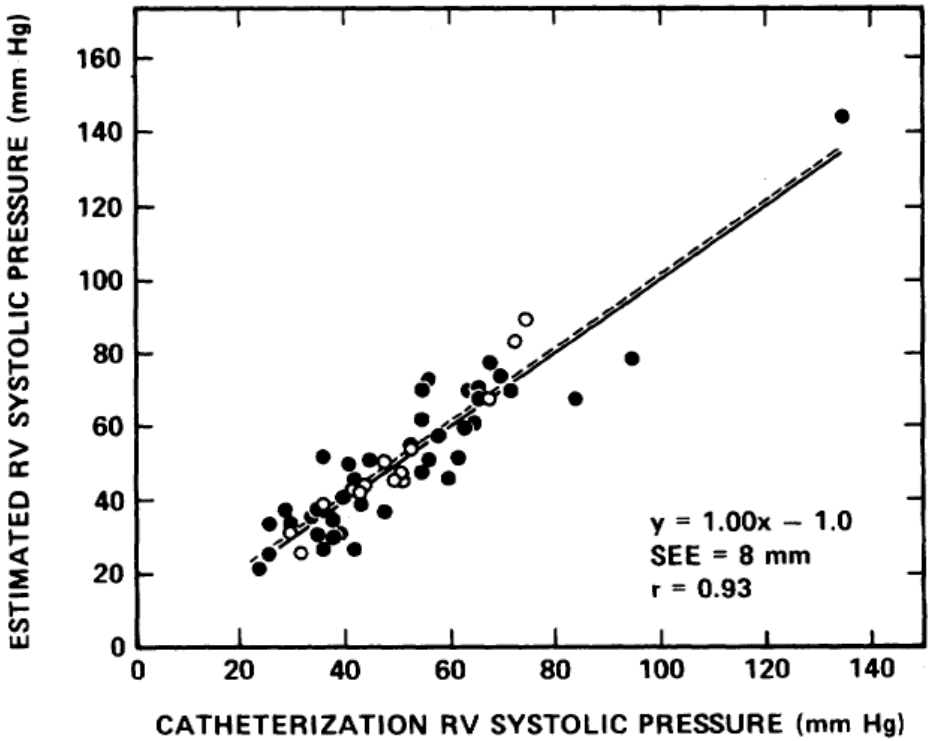
	MELODY[3]	SPHERE-HF[8]	Guazzi et al.[4]	SIOVAC[5]	DYNAMIC[6]	Hoendermis et al.[7]
mPAP	47 mmHg	42 mmHg	37 mmHg	38 mmHg	36 mmHg	35 mmHg
mPAWP	20 mmHg	22 mmHg	22 mmHg	23 mmHg	21 mmHg	20 mmHg

Maeder MT. Eur J Heart Fail 2023

PH Definition 2022







Yock&Popp. Circulation 1984

Thank you!

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