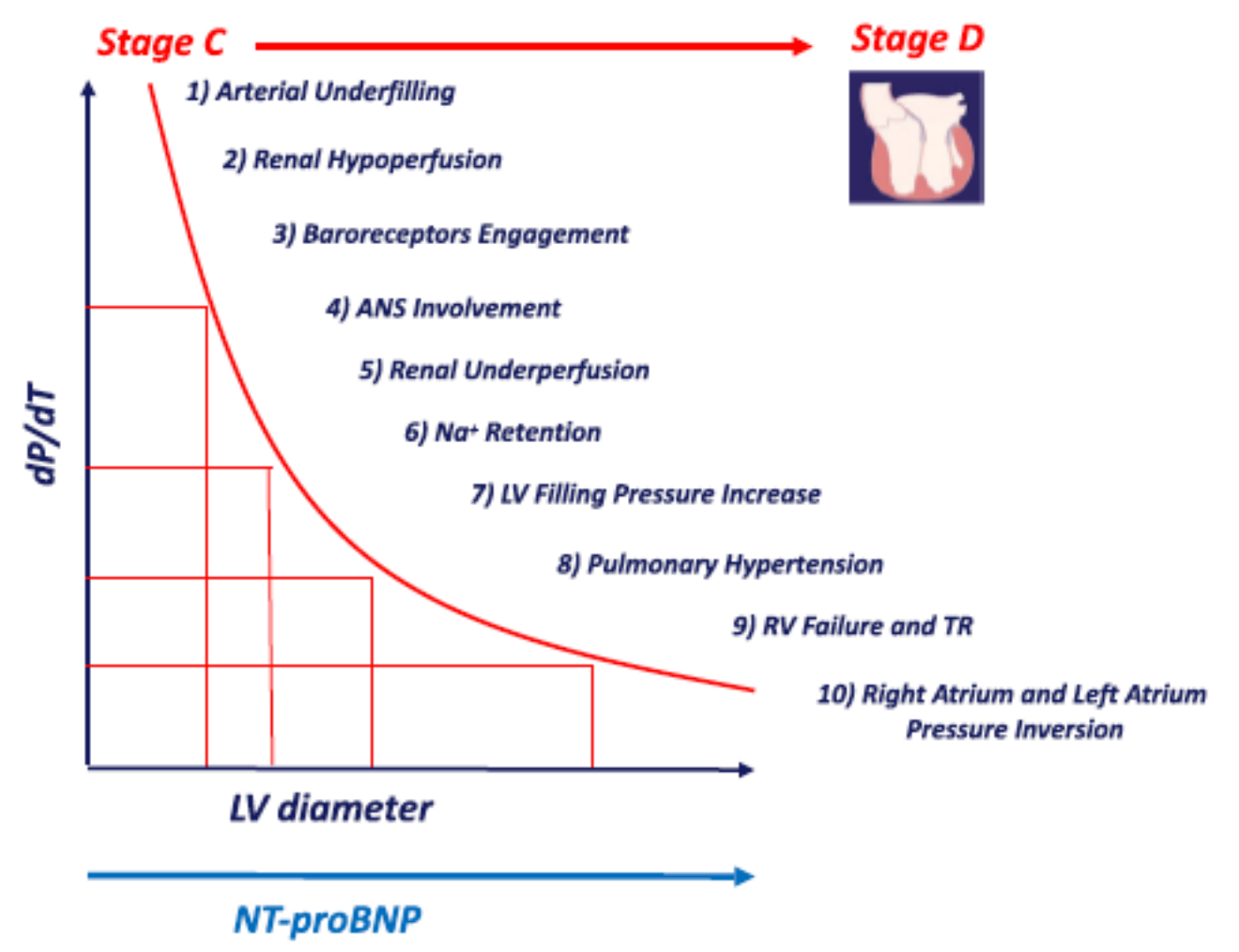
Sessió Societat Catalana de Cardiologia:
El Cor dret també existeix

Valoració del ventricle dret a la IC

José González Costello
Servei de Cardiologia
Hospital Universitari de Bellvitge - IDIBELL
Universitat de Barcelona
L'Hospitalet de Llobregat. Barcelona.

RV failure is the end-stage of HF



Gronda E et al. Heart Fail Rev 2020;25:295-303

Clinical case

- 56 years old male
- HTN, DM2, DLP
- 2006: anterior AMI Killip II thrombolysed. Difered coronariography: 2 vessel disease (LAD and RC). Stent in LADm and 3 months later stent in RC and PL because of angina. LVEF=35%
- Sept 2019: Admitted for HF at another center. LVEF=21%, apical aneurism. PAPs:50 mmHg. Repeat coronariography showed occluded stents in LAD and PL. Stent in RC OK. No acute lesions.
- Dec 2019: Paroxysmal AF, NOAC

Cardiac MRI Sept 2019

- Severly dilated LV (EDD:62 mm), ED volume: 166 ml/m^2. LVEF=14%, CI=1,9 l/min/m^2
- RV: EDD:37 mm, RVEF=73%
- ICD implant after MRI

FC III NYHA, PAPs=50 mmHg despite OMT
Refer to advanced HF center?

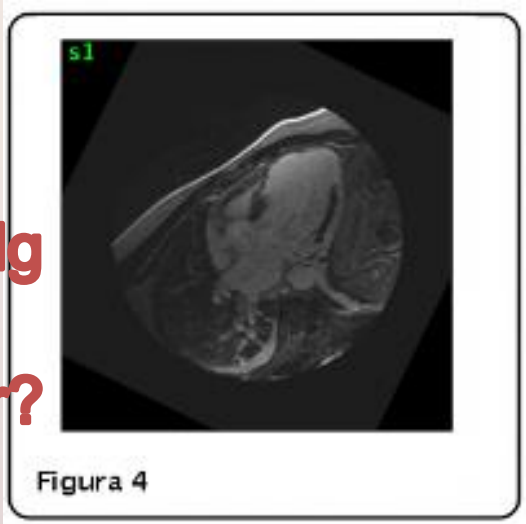


Figura 4

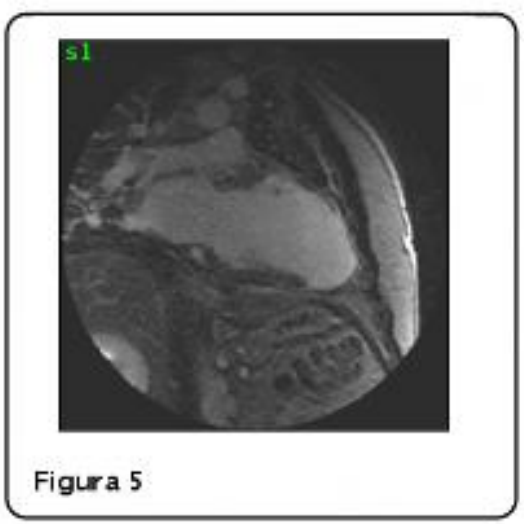
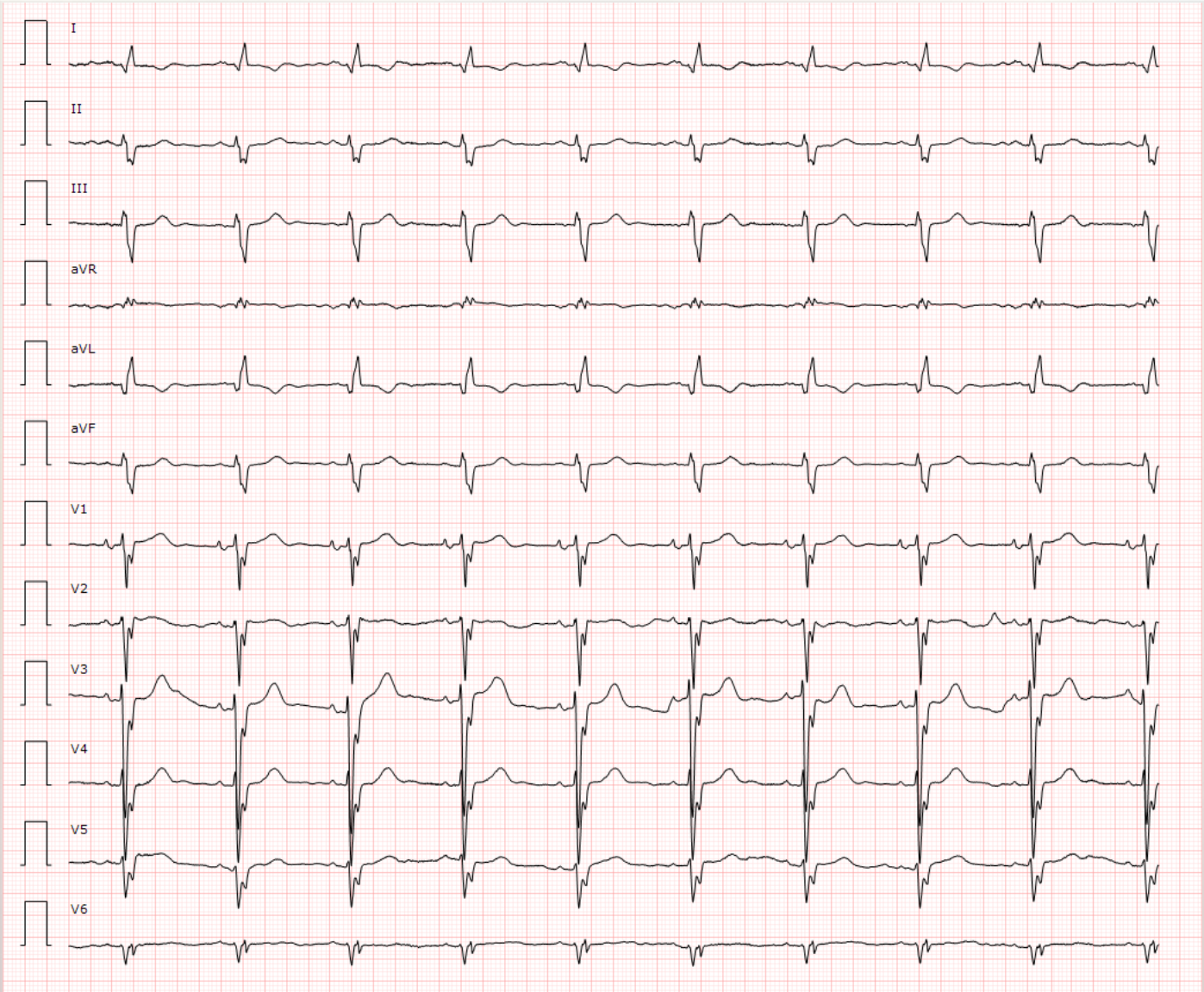


Figura 5

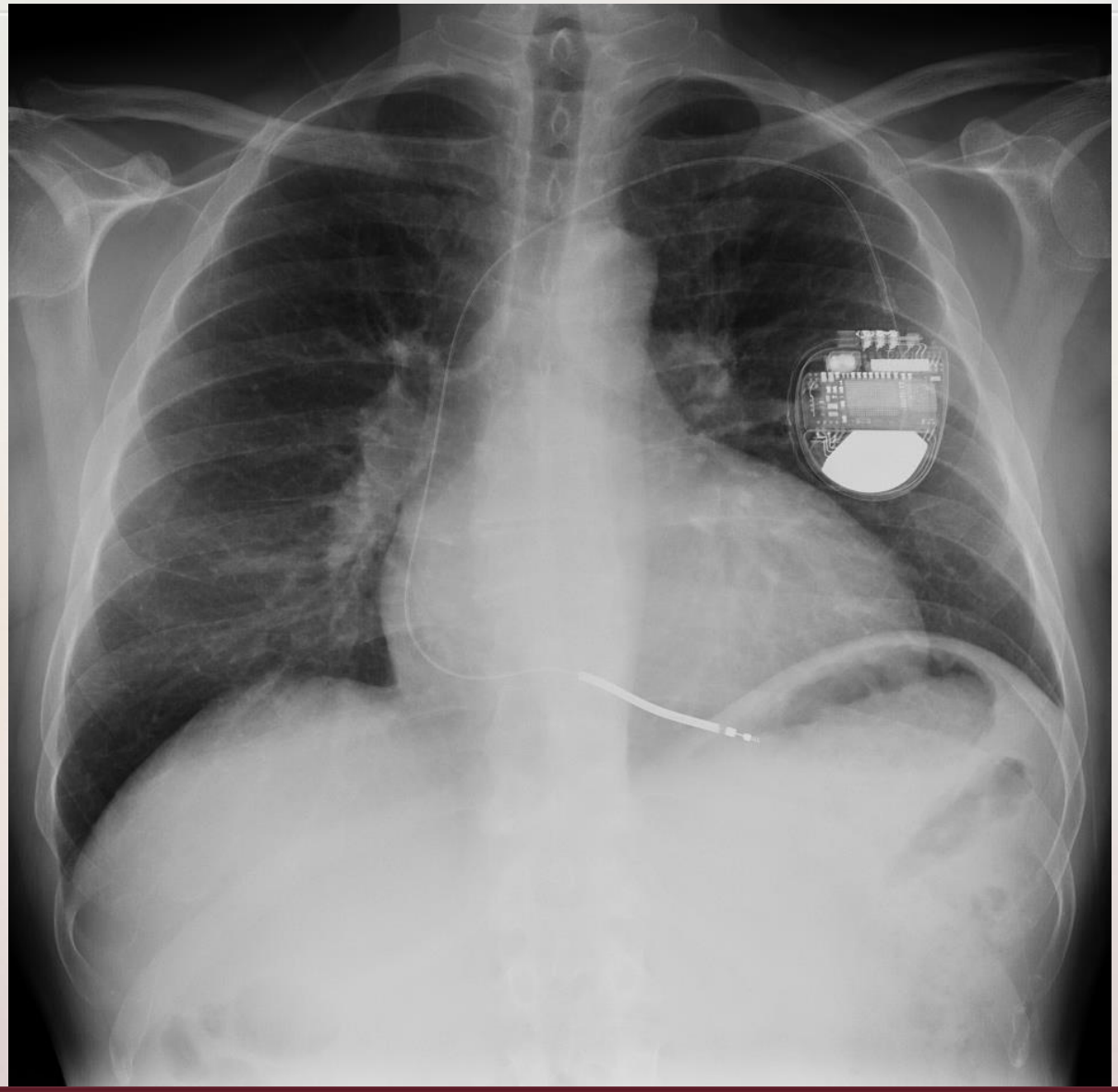
Patient not doing well

- February 2020: Patient admitted for biventricular worsening HF despite OMT
- June 2020: New admission for HF. Increased furosemide (120 mg/day) and Levosimendan
- July 2020: New admission and referred to HUB
- PE: BP:110/74 mmHg, HR:56 bpm, Mitral systolic murmur, elevated JVP, bilateral edemas
- 6MWT (after levosimendan): 279 meters.
- Analysis: GFR:50 ml/min, Sodium:133 mmol/L, ALT:80 U/L, Albumin:43 g/L, Bilirubin:24 umol/L, Hb:8,9 g/L, TP:1,09

ECG

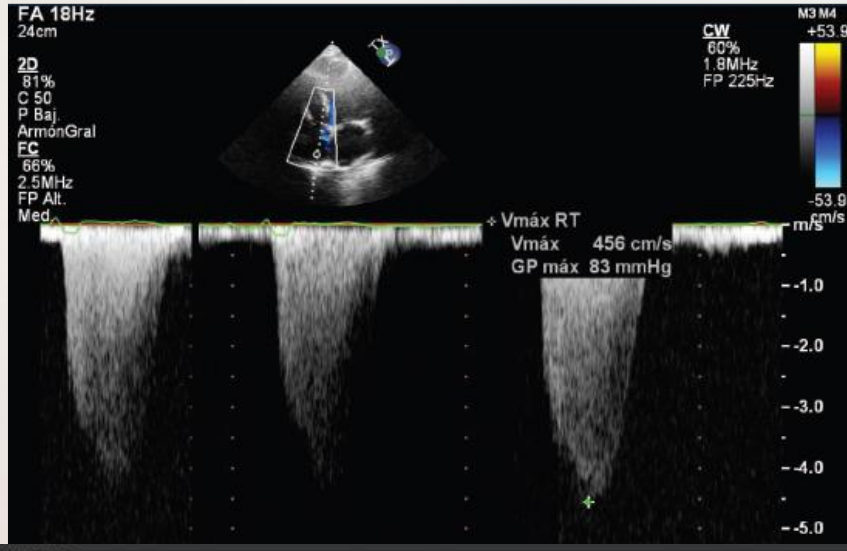


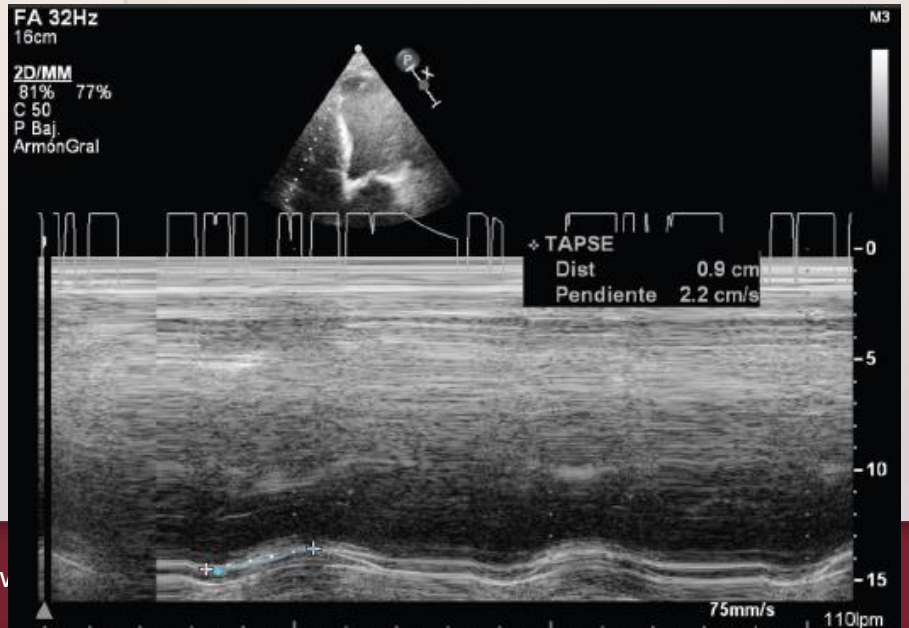
Chest Xray

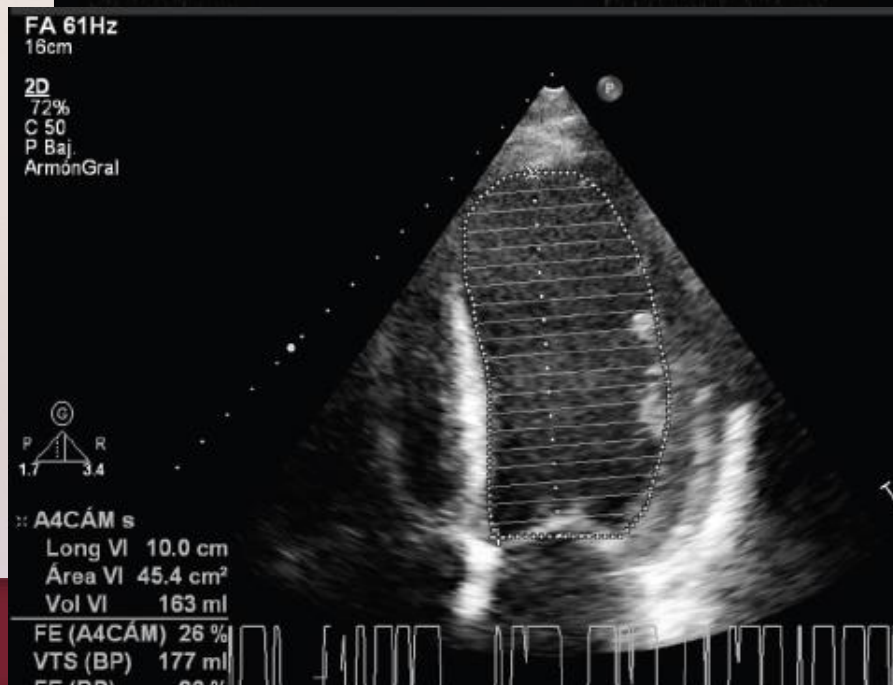


Echocardiogram at referring center

- LV (59 mm, 240 ml) and IVS:15 mm with LVEF=26% and restrictive filling. MR III
- RV severely dilated (50 mm) with TAPSE:9 mm. S':9 cm/s.
- TR II with PAPs > 60 mmHg
- IVC dilated and fixed





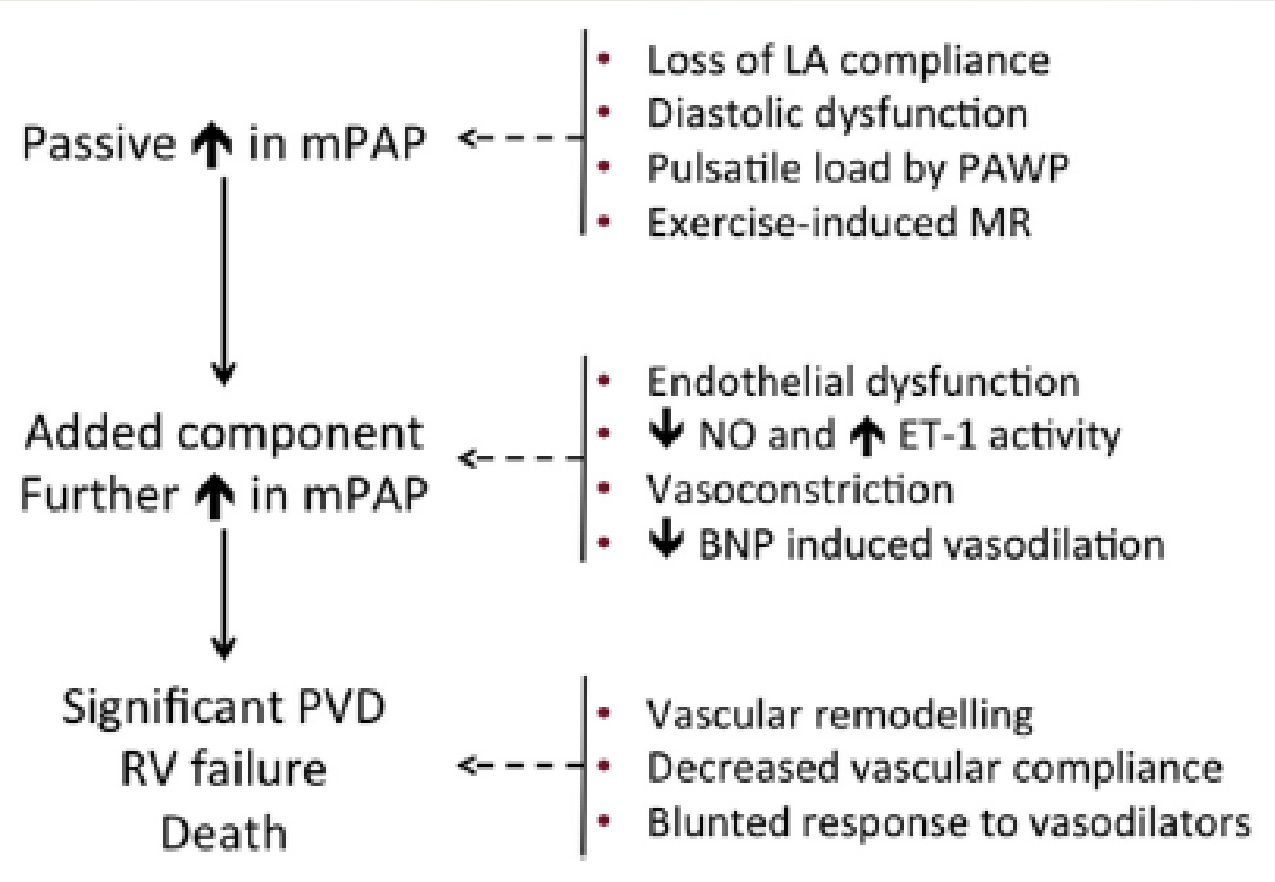


Can the RV cope with an LVAD?

1. Definetely not, RV is too bad
2. Maybe, if you can optimize him
3. Definetely yes, the main problema is the LV

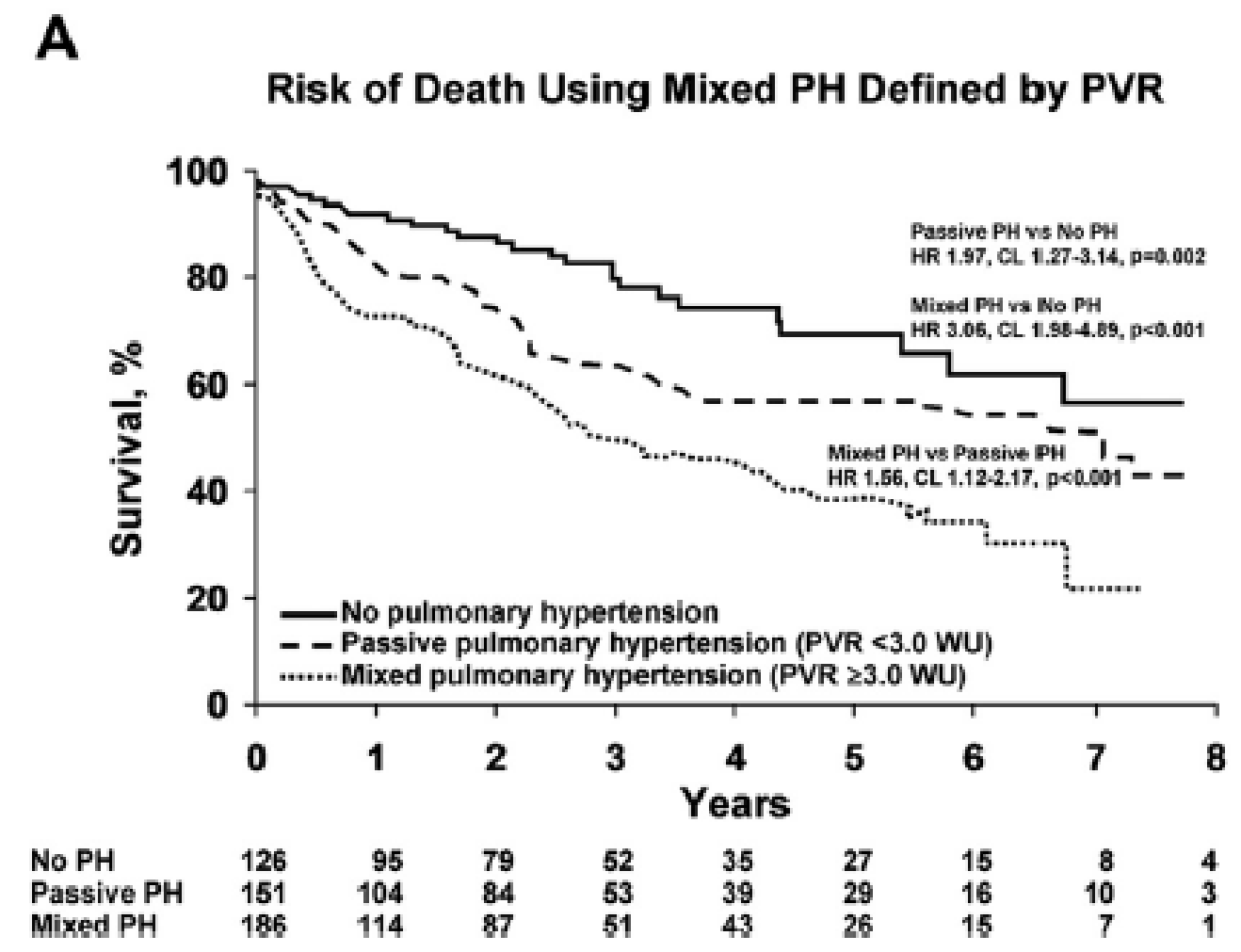
Importance of early referral for LVAD/HT before RV fails

Why does the RV fail in HF patients?



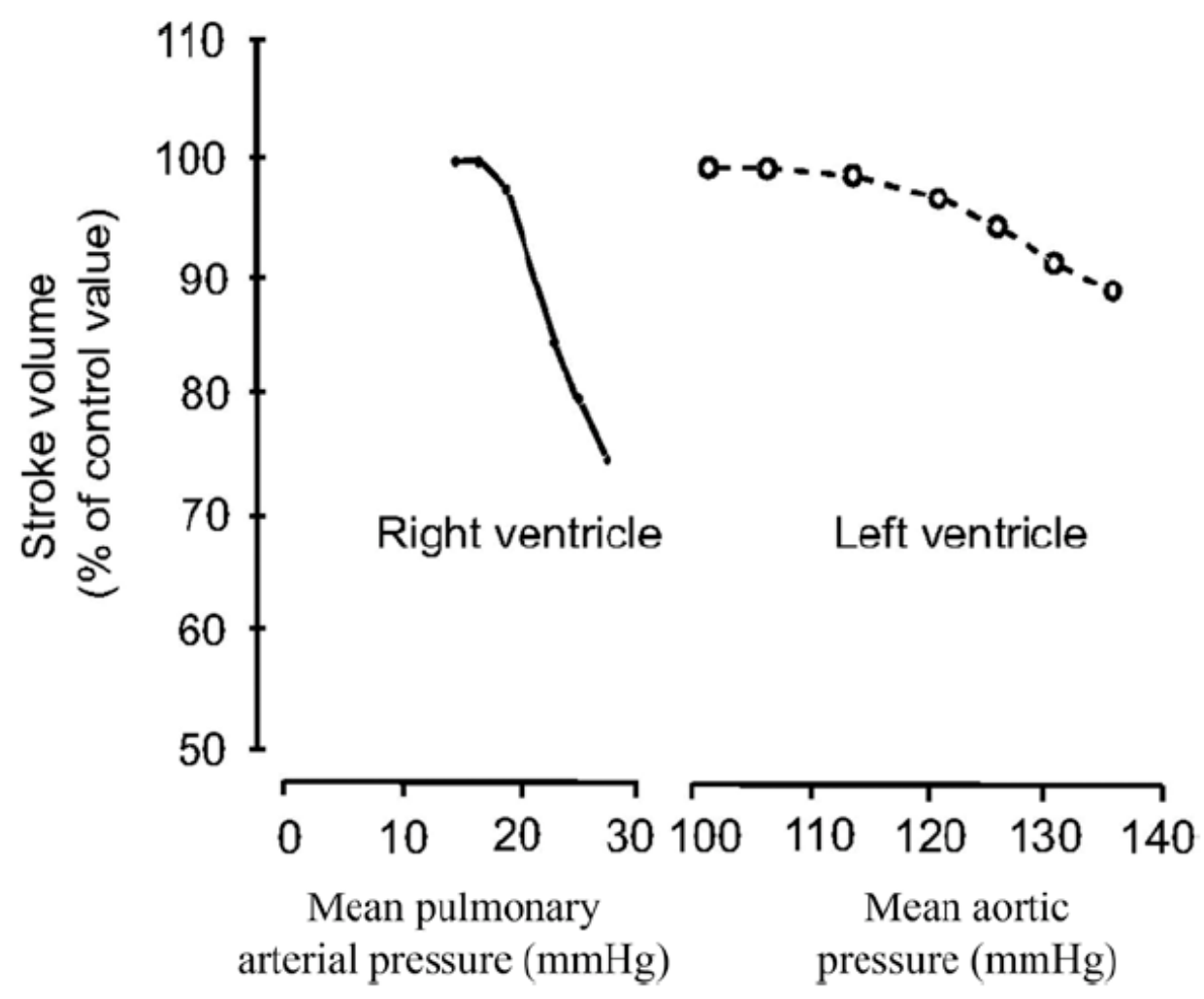
Vachery et al. JACC 2013

PVR is a prognostic marker in HF



Miller et al. JACC HF 2013

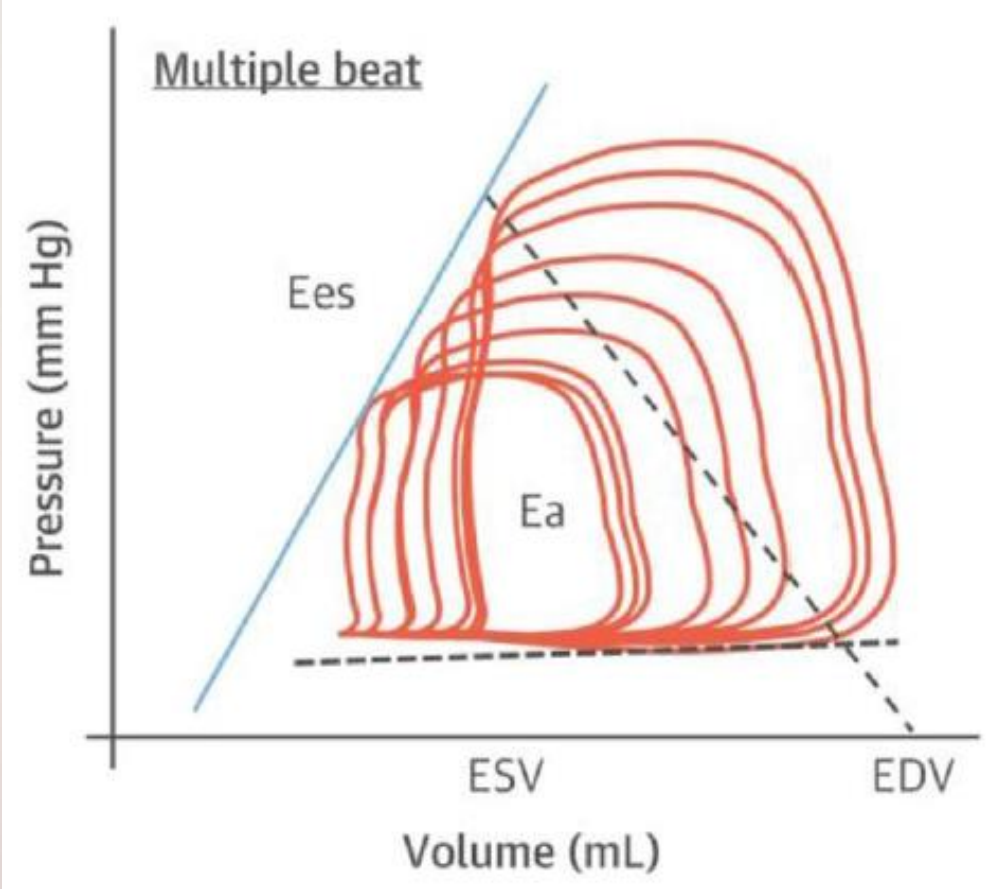
How does the RV respond to an increase in afterload?



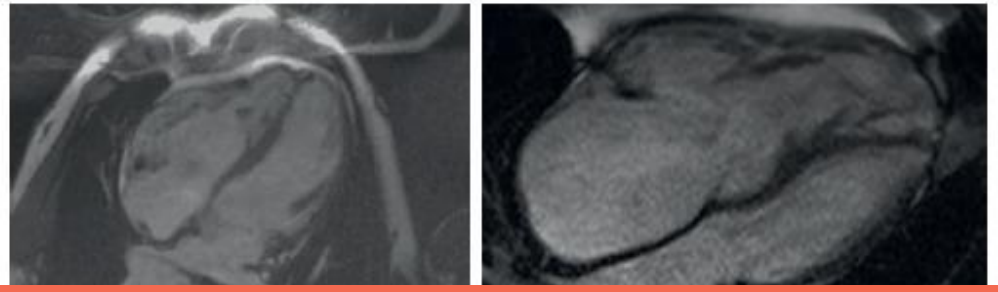
Konstam MA et al. Circulation 2018;137:e578

RV physiology

- Ees (End systolic elastance) is a load independent measure of RV contractility
- Ea (efective arterial elastance) is a measure of RV afterload: End systolic pressure/SV
- Ees/Ea defines RV-PA coupling

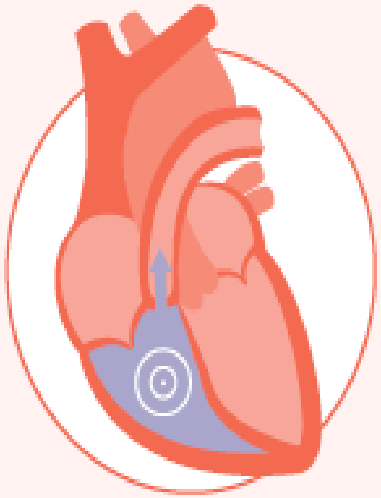


Konstam MA et al. Circulation 2018;137:e578

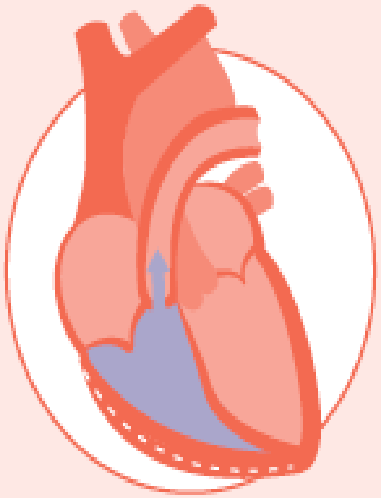


The Right Ventricle and Its Load in Pulmonary Hypertension

Pulmonary vessel narrowing leads to increased vascular load on right ventricle (RV)



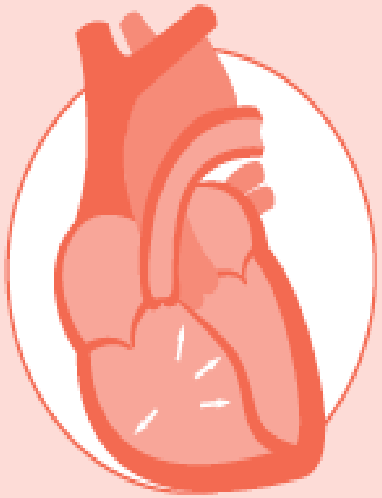
RV adapts by increasing muscle contractility and wall thickness ("coupling")



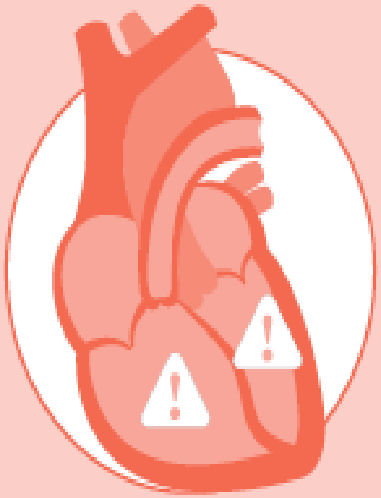
To maintain cardiac output, RV dilates and heart rate increases

Increase in wall stress and oxygen consumption per gram follow

Leftward septal bowing results



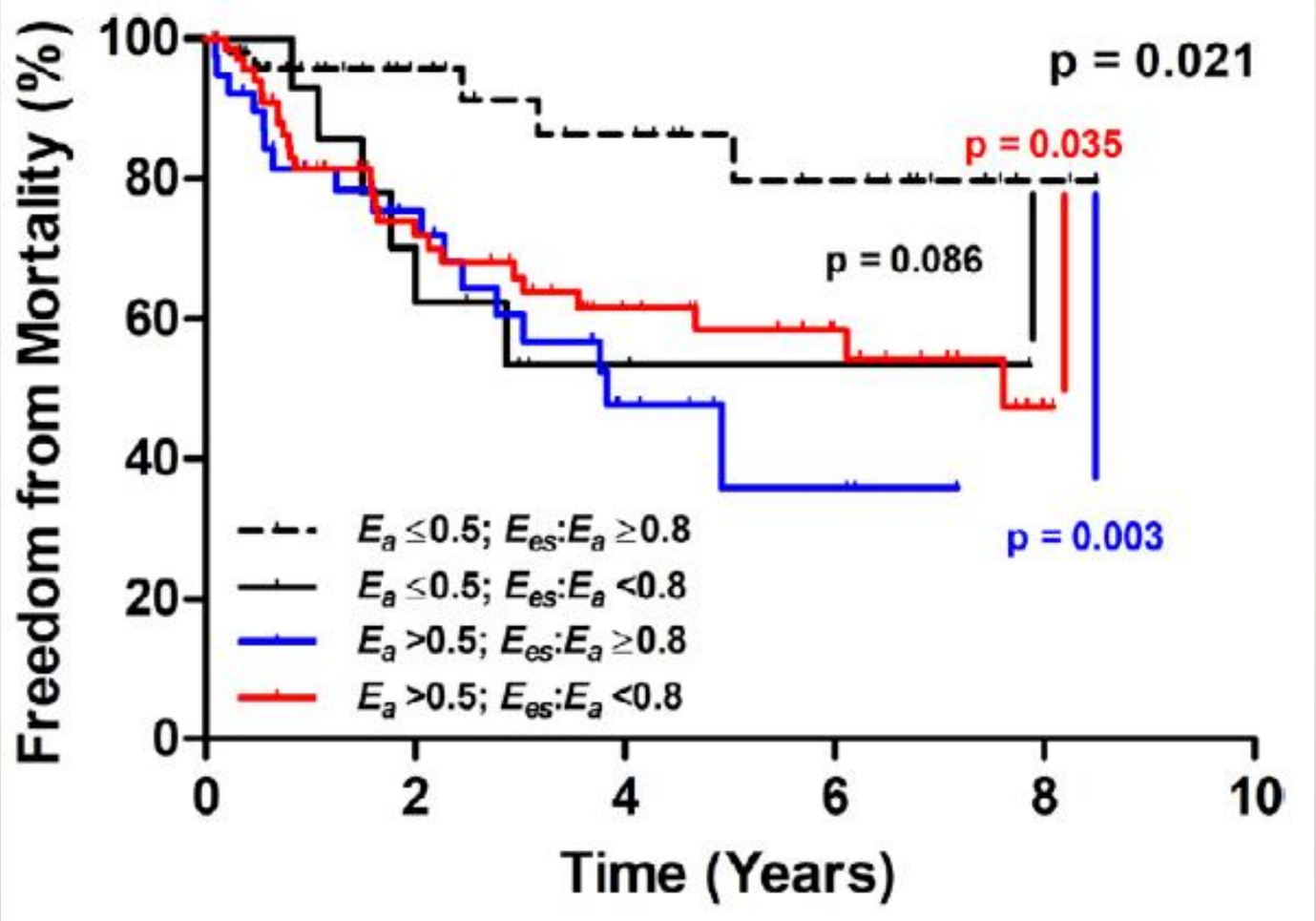
Final stage: Uncoupling occurs with high metabolic demand and reduced output



Right Ventricular Volume (ml)

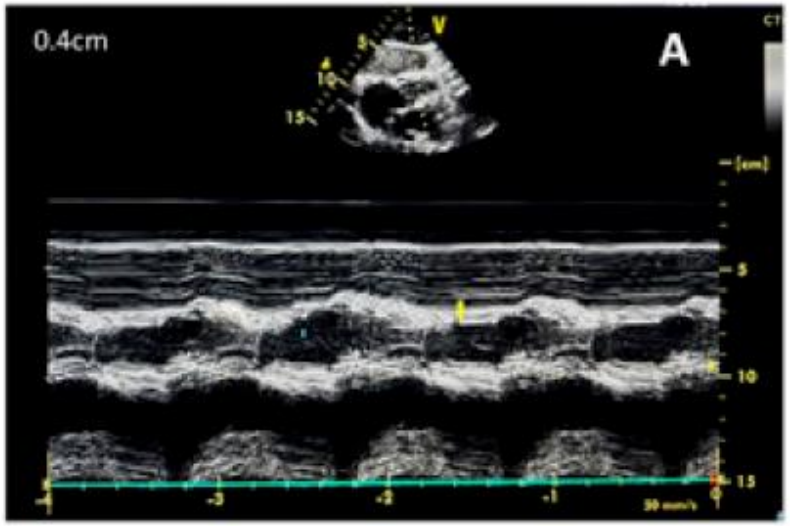
Noordegraaf AV et al. JACC 2017;69:236

Pulmonary Elastance and RV uncoupling imply worse prognosis in advanced HF

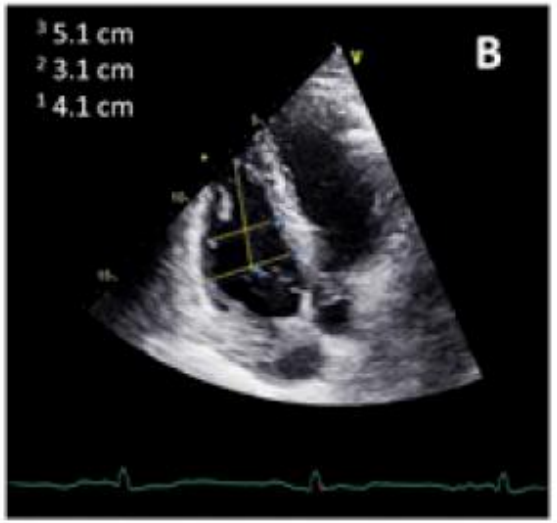


Wright SP et al. J Heart Lung Transplant 2020;39:657

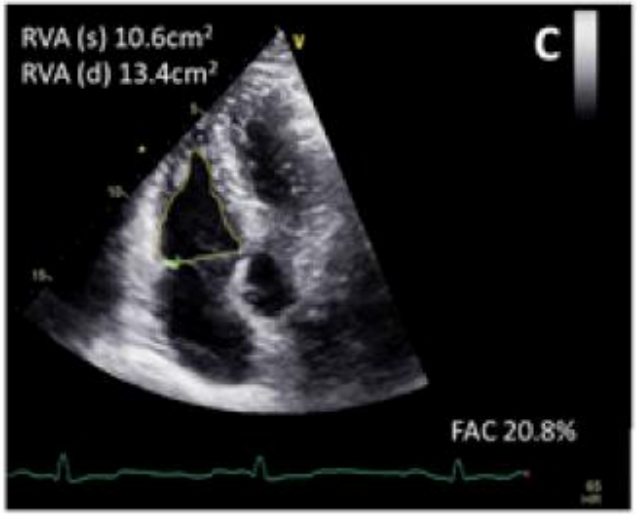
How to evaluate the RV?: Echo



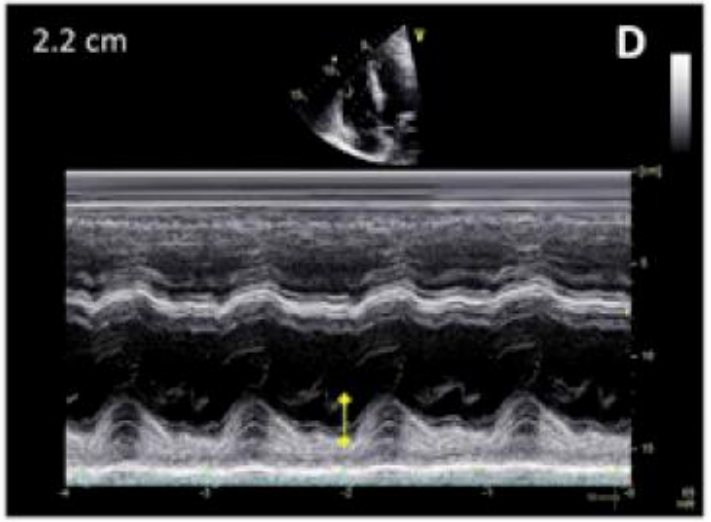
RV wall thickness <5 mm



Normal RVEDD/LVEDD ratio <1.0
RV basal diameter <41 mm



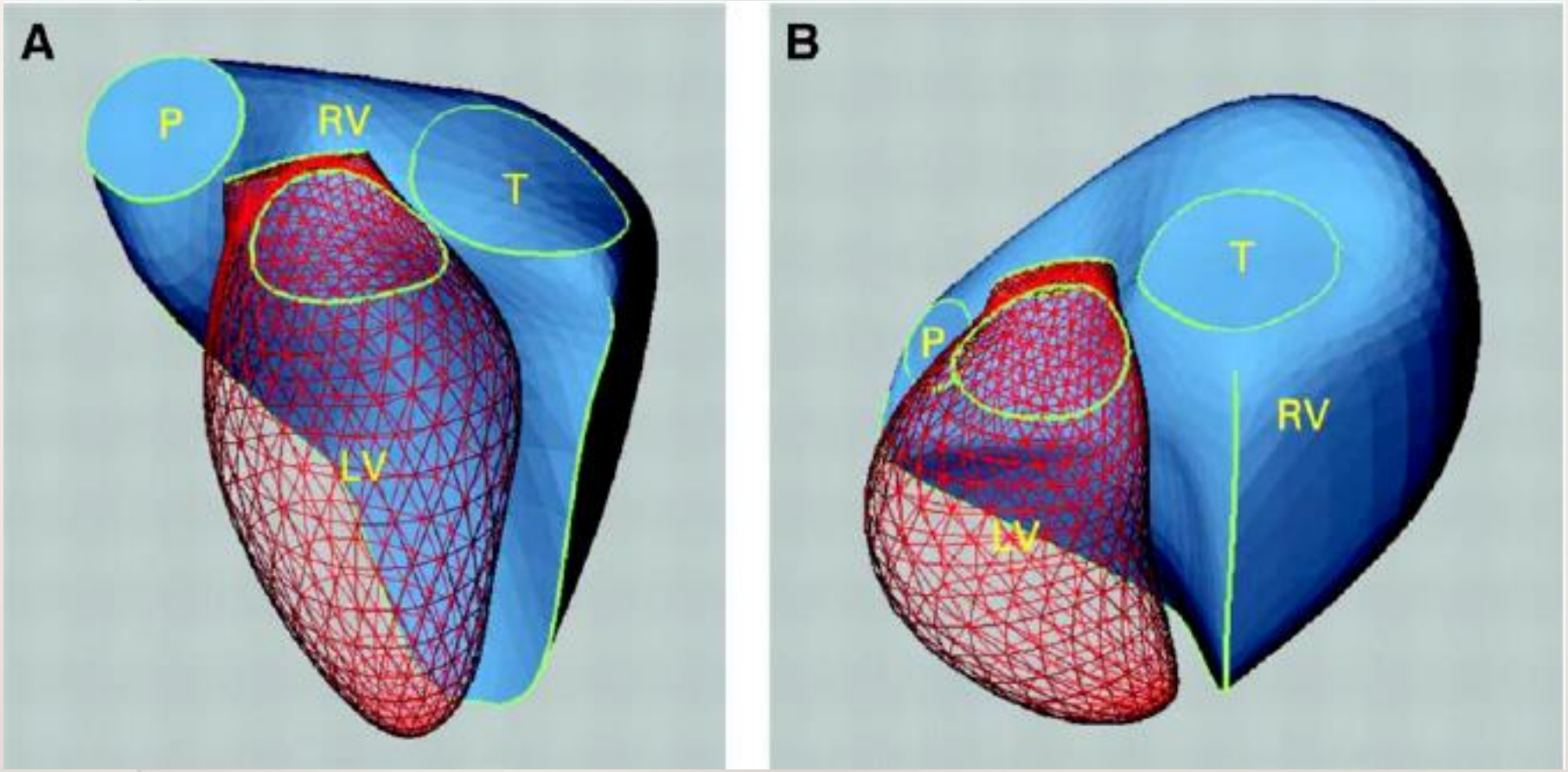
RV fractional area change FAC <35%



Tricuspid annular plane systolic excursion
TAPSE >17mm

Berglund F. et al Heart 2020;106:1798

But the RV anatomy is more complex



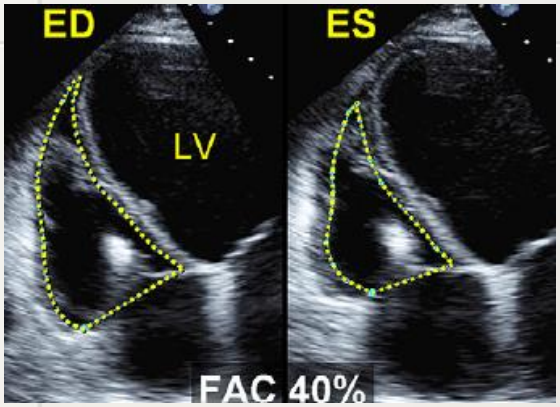
Health

Disease

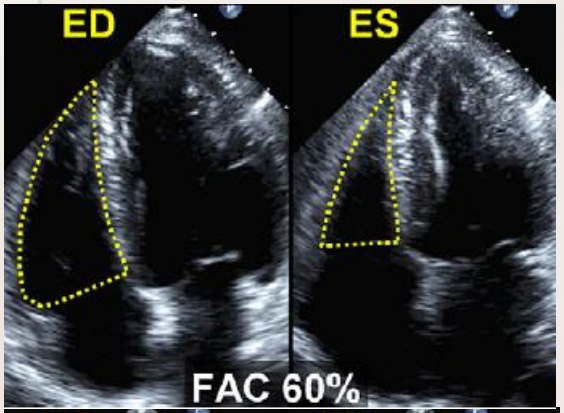
Konstam MA et al. Circulation 2018;137:e578

Echo evaluation can be inaccurate

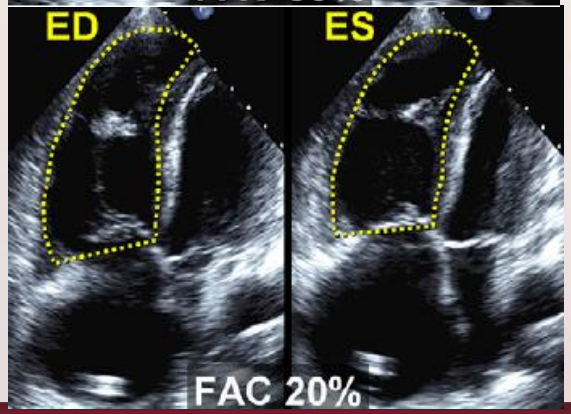
3

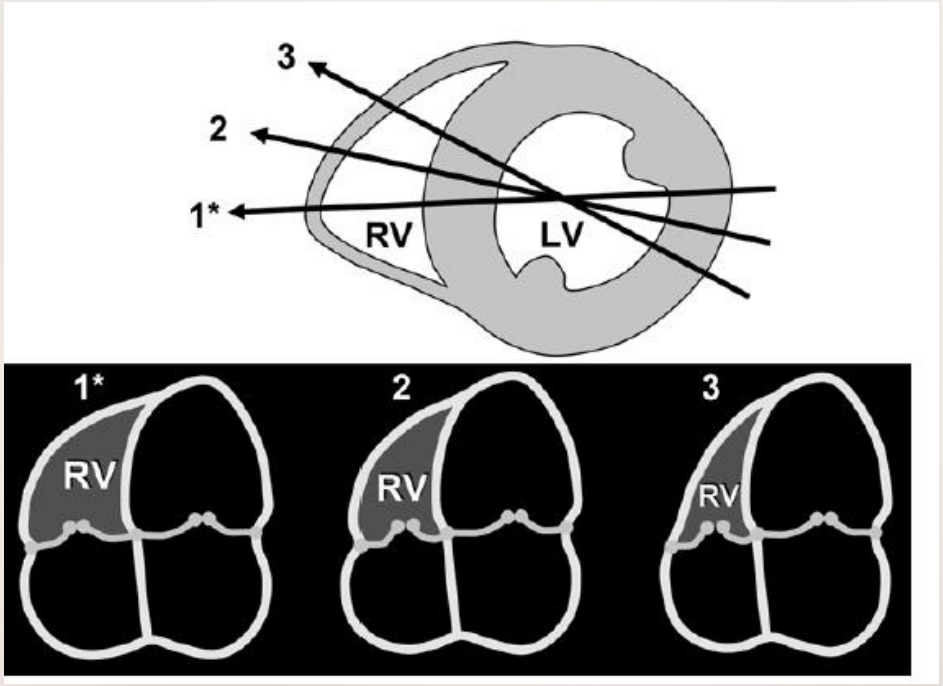


2



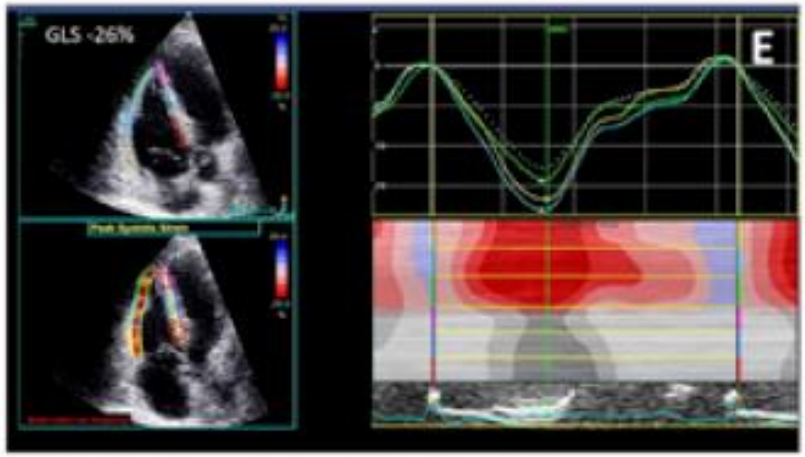
1



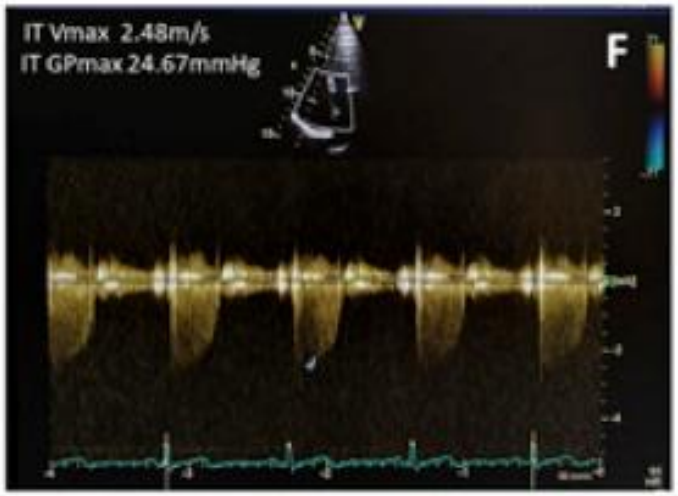


Rudski et al. J Am Soc Echocardiogr 2010

How to evaluate RV?: Echo

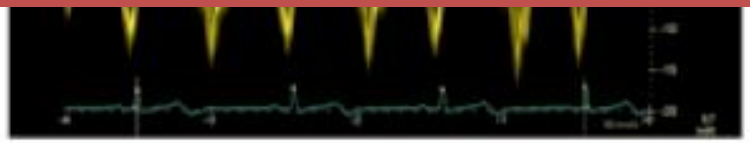


RV Global Longitudinal Strain >20%



Tricuspid regurgitation peak systolic velocity of TR <2.8 m/s

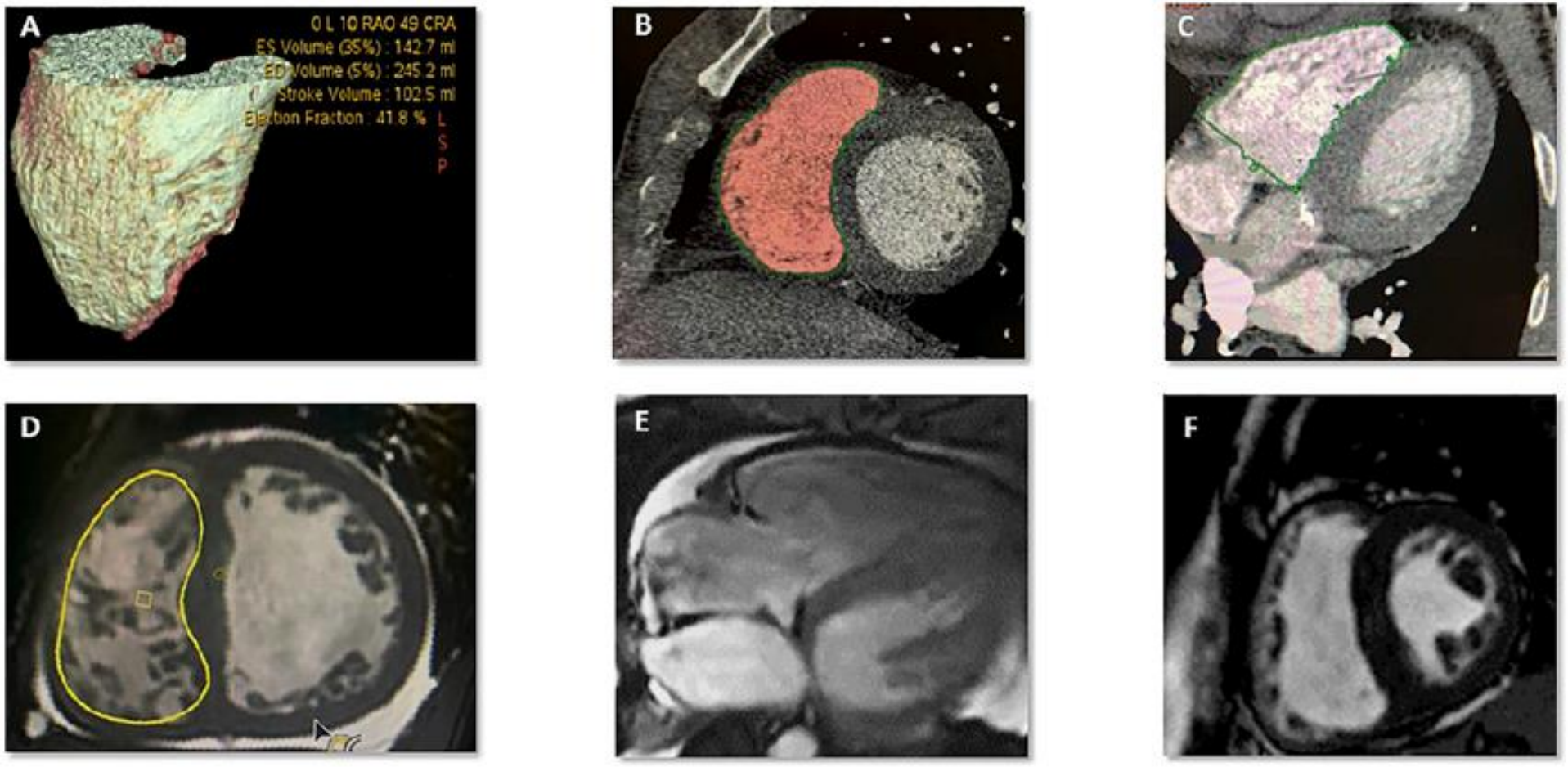
TDI influenced by loading conditions



Tricuspid annular systolic S' velocity of >9.5 cm/s

RV index of myocardial performance <0.40

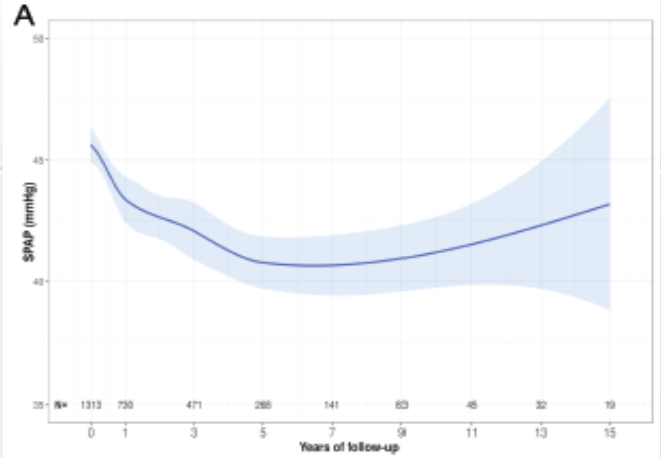
RV EF better evaluated with CT or MRI

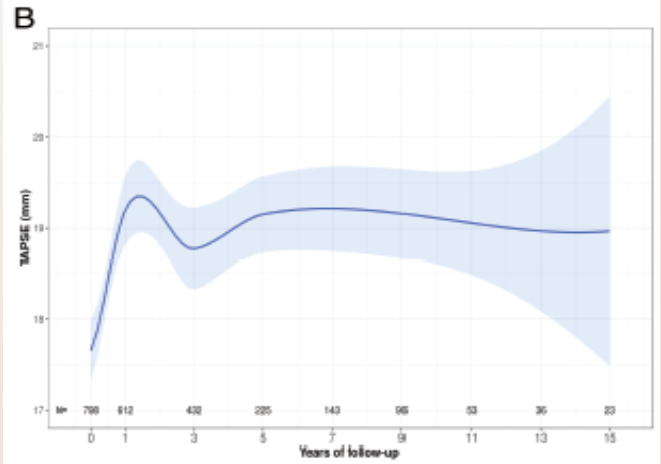


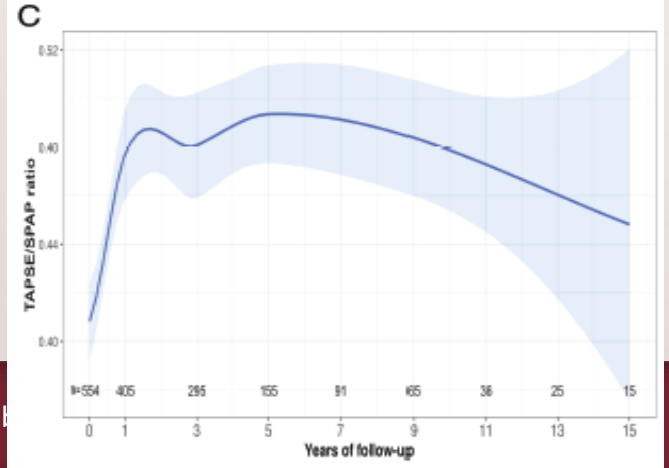
Berglund F. et al Heart 2020;106:1798

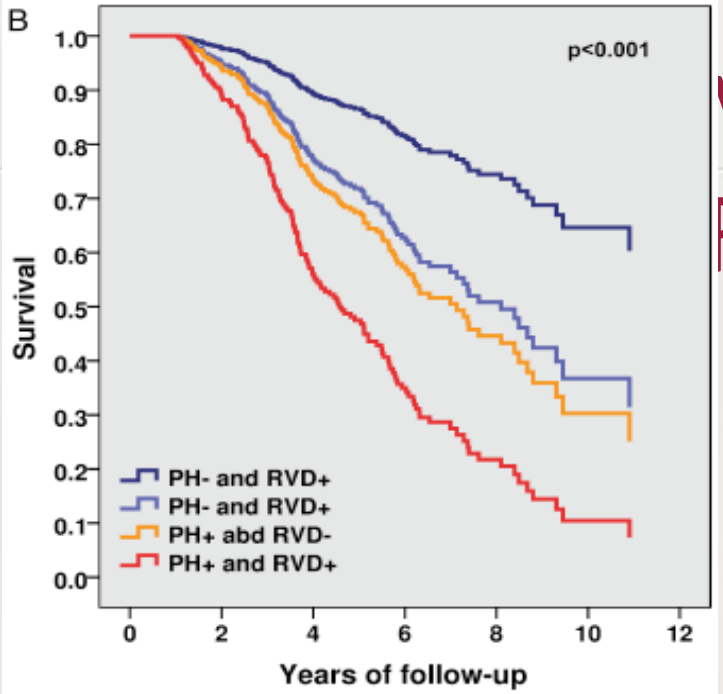
ve

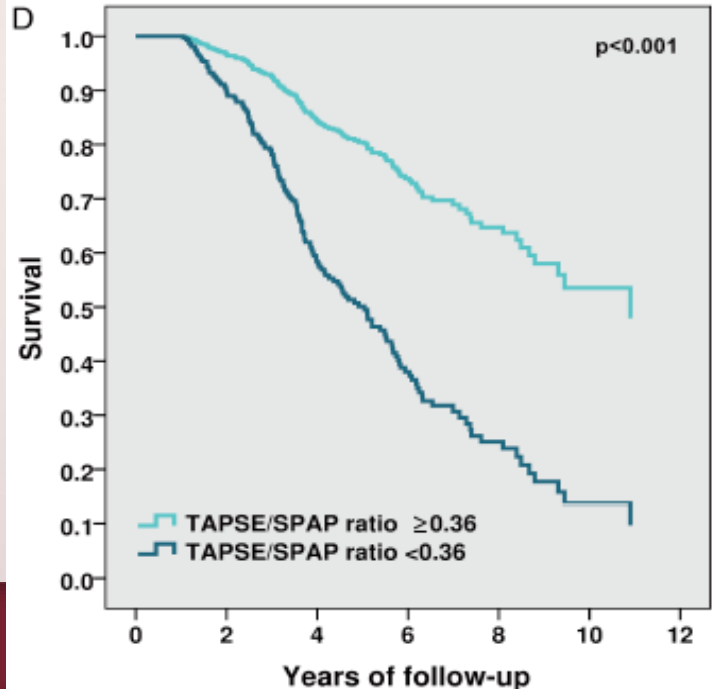
RV-PA





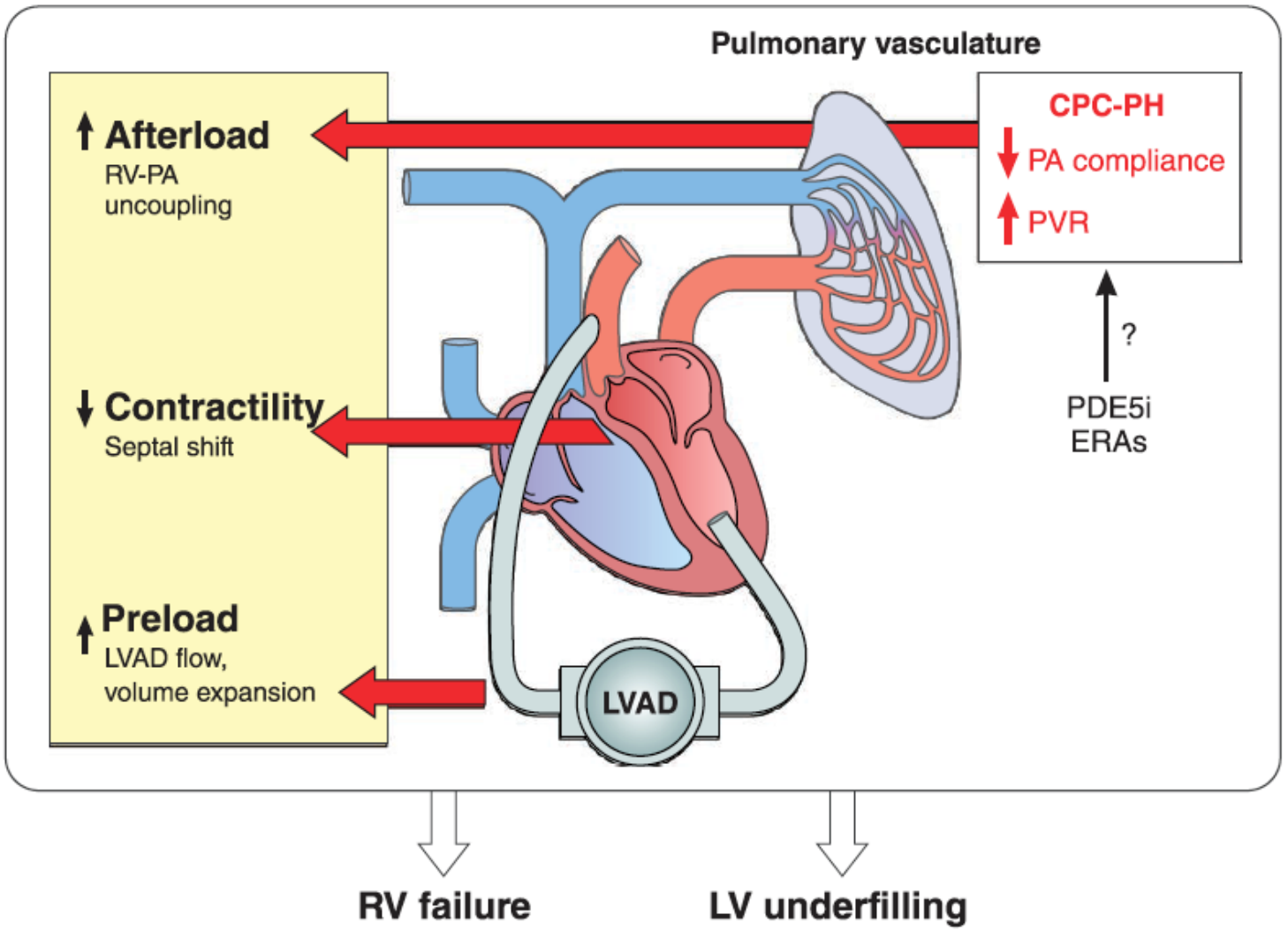






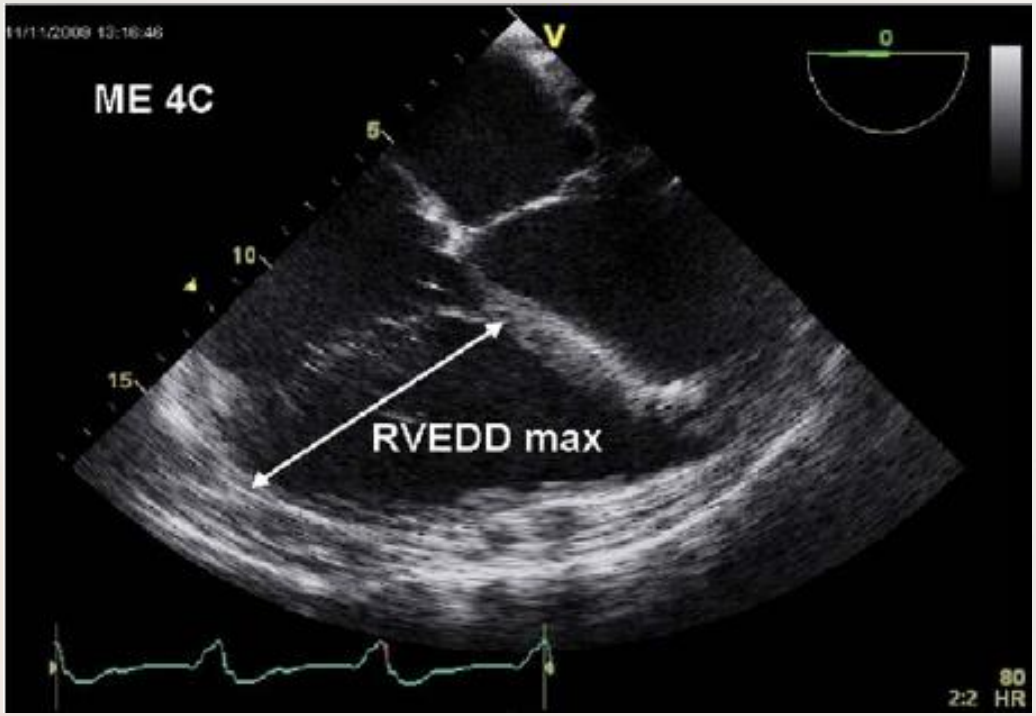
Santiago E et al. EJHF 2020;22:1214

Impact of LVAD on RV



Sparrow et al. Circ HF 2018; 11:e004255

How to evaluate RV for LVAD?



Ratio RV/LV > 0,72
Ratio Short/Long RV > 0,6
TAPSE < 8 mm
Longitudinal peak systolic strain rate TA < 6 cm/s
Severe TR with PAPs < 50 mm Hg

Kukucka et al. J Heart Lung Transpl 2011
Dandel et al. Circulation 2013

Variable	RVF		p Value
	Yes (n = 35)	No (n = 76)	
Hemodynamic variables			
Cardiac index (L/min/m^2)	1.6 ± 0.4	1.7 ± 0.4	0.574
Pulmonary arterial wedge pressure (mm Hg)	22.0 ± 7.4	25.2 ± 10.6	0.153
Mean pulmonary artery pressure (mm Hg)	31.9 ± 9.0	36.3 ± 11.7	0.080
Mean right atrial pressure (mm Hg)	11.9 ± 7.7	9.7 ± 7.2	0.194
Right ventricular stroke work index (mm Hg/ml/m^2)	330 ± 160	463 ± 180	0.002
Laboratory examinations			
Hematocrit (%)	33 ± 8	35 ± 6	0.271
Platelet count (×1(		212 ± 97	0.222
Sodium (mEq/L)		131 ± 9	0.649
Potassium (mEq		0.6	0.502
Blood urea nitrogen (mg/dl)	30 ± 14	34 ± 18	0.171
Creatinine (mg/dl)	1.4 ± 0.5	1.5 ± 0.5	0.212
Albumin (mg/dl)	3.4 ± 0.6	3.7 ± 0.6	0.028
Total bilirubin (mg/dl)	2.1 ± 1.6	1.6 ± 0.8	0.018
Direct bilirubin (mg/dl)	0.8 ± 0.9	0.5 ± 0.4	0.011
Aspartate amino transferase (U/L)	44 ± 47	47 ± 75	0.797
Alamine aminotransferase (U/L)	50 ± 87	64 ± 121	0.560
Brain natriuretic peptide (pg/ml)	1,766 ± 683	1,516 ± 599	0.053

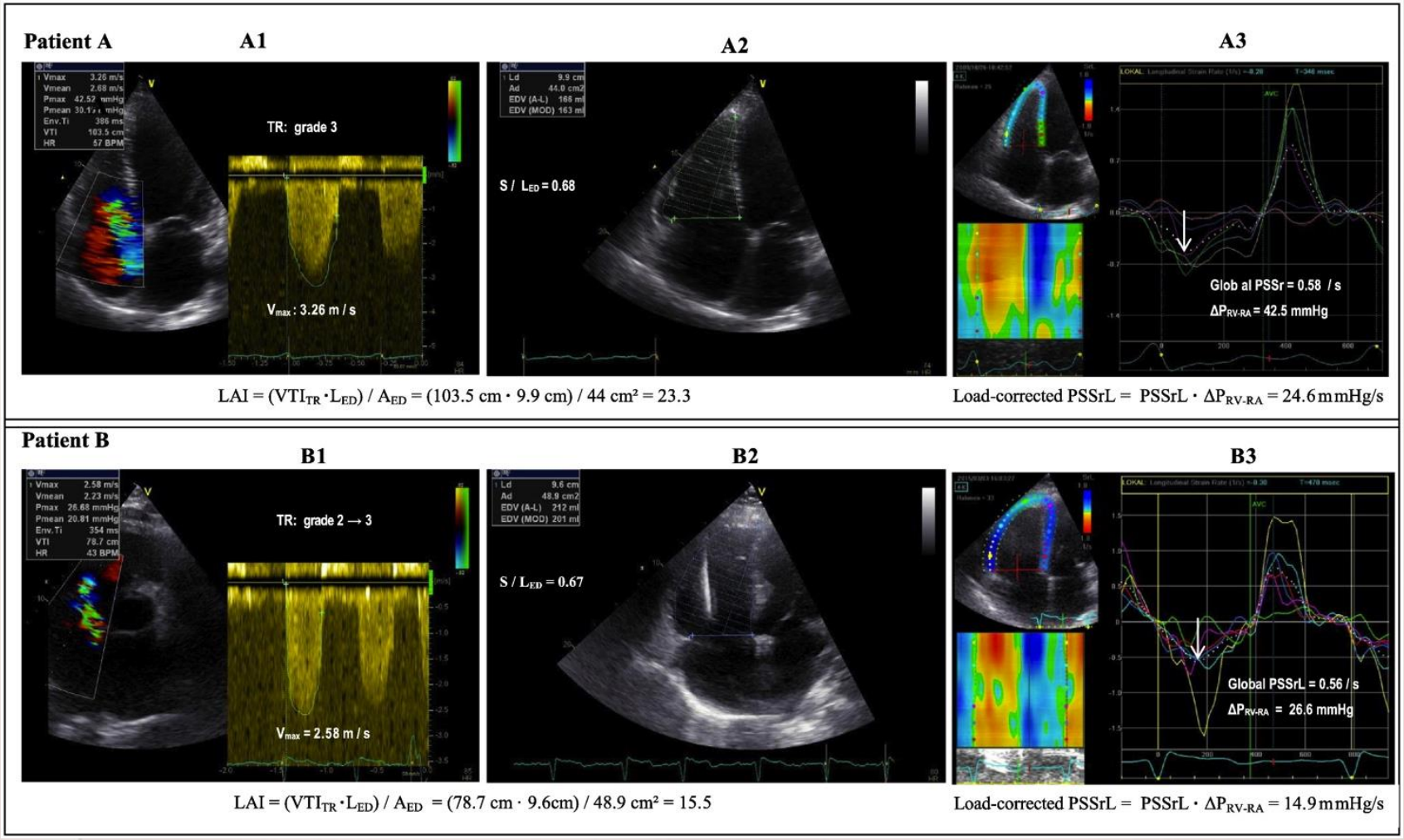
RVSWI= (PAPmean – CVP) x (CI/HR) x 1000 < 400

CVP/Wedge > 0.63*

PAPi: PAPs-PAPd/CVP < 2**

Kato et al. Am J Cardiol 2012;109:246 **Kang G et al. JHLT 2016:35:67
*Kormos et al. J Thorac Cardiovasc Surg 2010;139:1316

Combine haemodynamic and echo parameters



LAI: Load adaptation index; VTI TR: TR velocity-time integral; L_{ED}:Length ED
A_{ED}: Area ED; PSSrL: Peak systolic strain rate longitudinal

Dandel et al. Int J Cardiol 2015;198:241

EUROMACS-RHF risk score

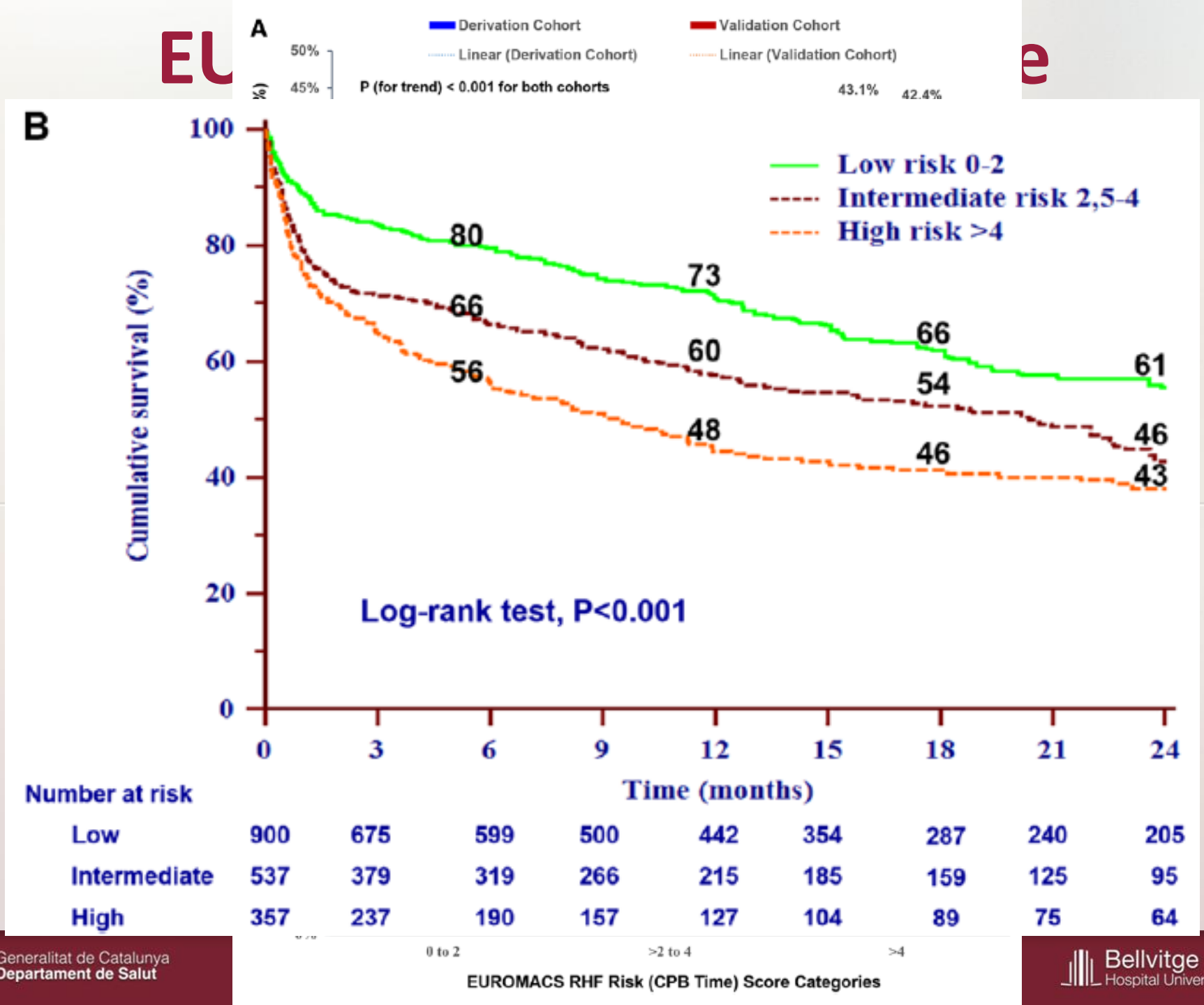
- A score to prevent early RV failure defined as:
  - Need for RVAD
  - Need for inotropes > 14 days
  - Need for NO > 48 hours

Score 0-2: Low risk
Score 2.5-4: Intermediate risk
Score > 4: High risk

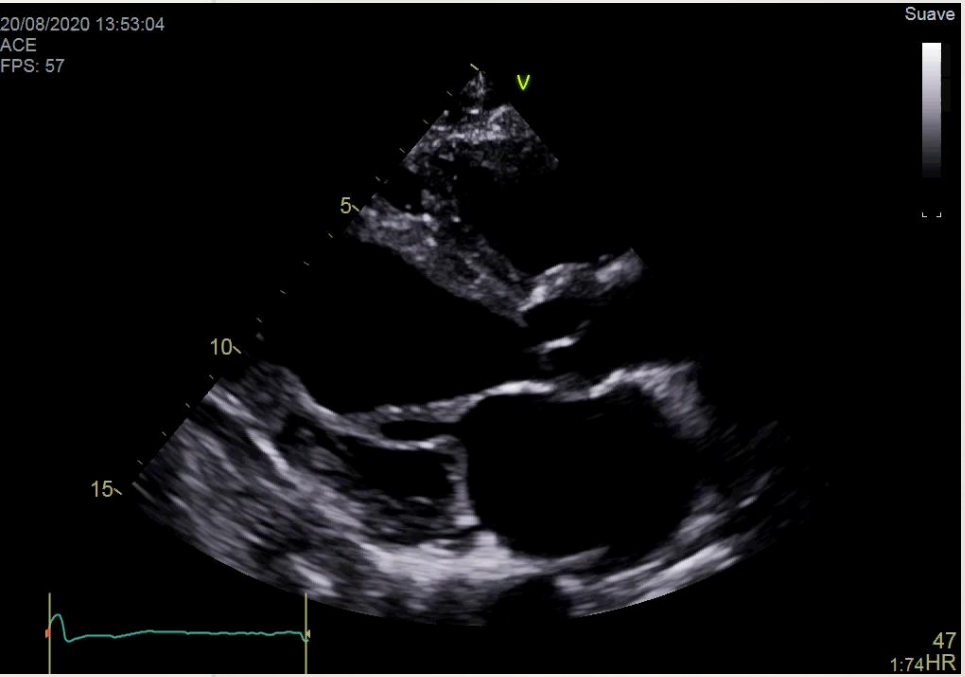
Variables	OR	Lower 95% CI	Upper 95% CI	χ^2 Value (χ^2=56.9)	Coefficients	Score
Preoperative model						
RA/PCWP >0.54	2.075	1.383	3.112	12.441	0.730	2
Hemoglobin ≤10 g/dL	1.611	1.037	2.502	4.506	0.477	1
Multiple intravenous inotropes	3.197	1.851	5.524	17.355	1.162	2.5
INTERMACS class 1–3	2.903	1.723	4.893	16.014	1.066	2
Severe RV dysfunction*	2.055	1.183	3.57	6.534	0.720	2
Postoperative RHF model after adding CPB time						
RA/PCWP >0.54	2.151	1.412	3.278	12.699	0.766	1
Hemoglobin ≤10 g/dL	2.609	1.544	4.409	12.839	0.959	1.5
Multiple intravenous inotropes	3.013	1.712	5.302	14.635	1.103	2
INTERMACS Class 1–3	3.393	1.946	5.915	18.561	1.222	2
Severe RV dysfunction*	2.099	1.193	3.694	6.618	0.742	1
CPB time >100 min	2.032	1.296	3.184	9.562	0.709	1

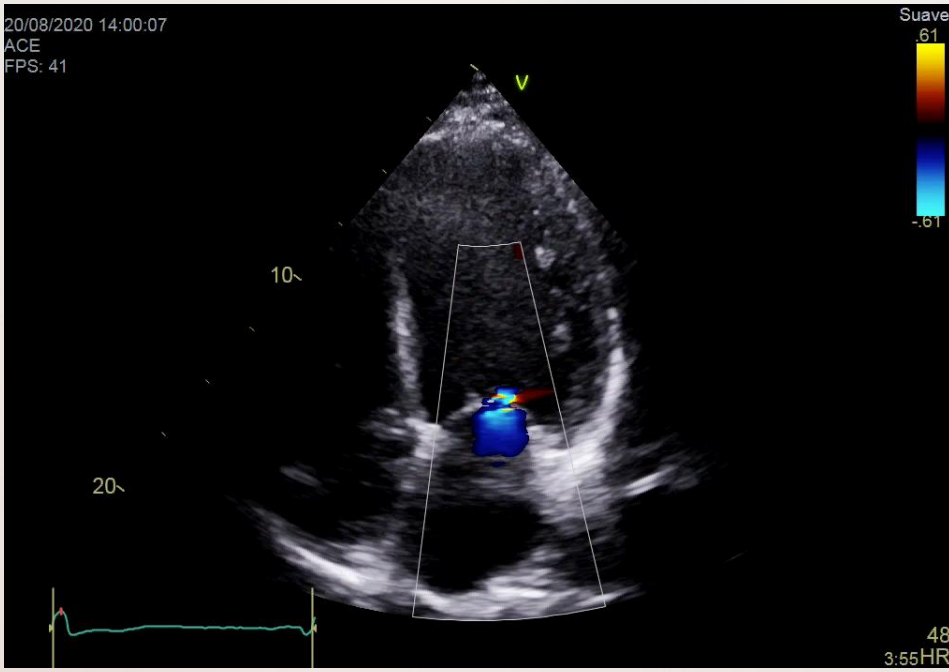
Soliman OI et al. Circulation 2017;137:891

EU e


A
Derivation Cohort
Validation Cohort
Linear (Derivation Cohort)
Linear (Validation Cohort)
50%
45%
P (for trend) < 0.001 for both cohorts
43.1%
42.4%
B
100
80
60
40
20
0
Cumulative survival (%)
Low risk 0-2
Intermediate risk 2,5-4
High risk >4
80
73
66
66
60
61
56
54
48
46
46
43
Log-rank test, P<0.001
0
3
6
9
12
15
18
21
24
Time (months)
Number at risk
Low 900 675 599 500 442 354 287 240 205
Intermediate 537 379 319 266 215 185 159 125 95
High 357 237 190 157 127 104 89 75 64
0 to 2
>2 to 4
>4
EUROMACS RHF Risk (CPB Time) Score Categories

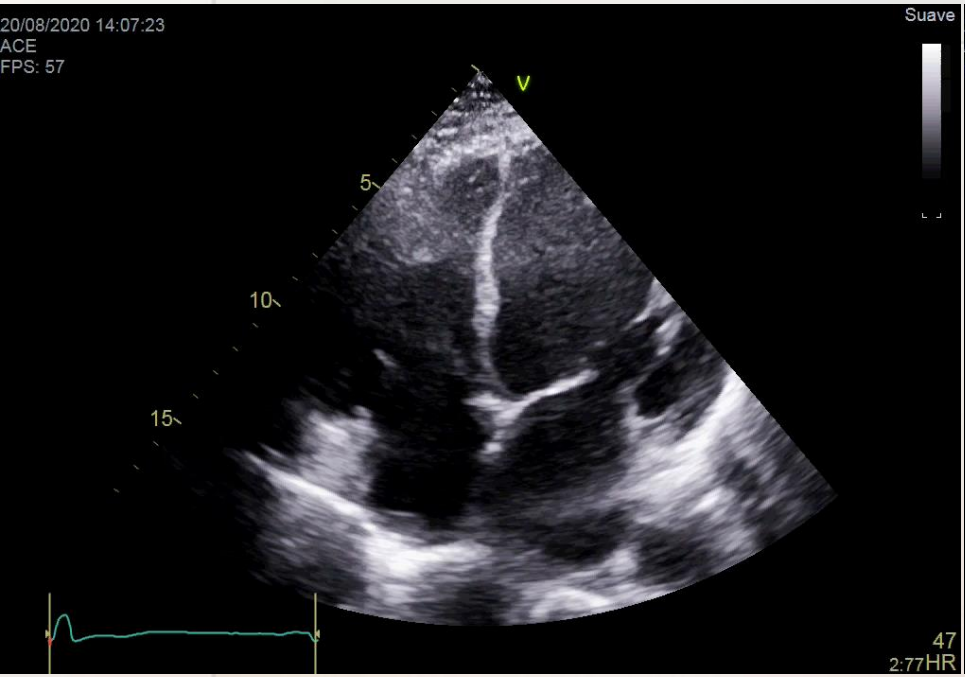
Echocardiogram after iv diuretic

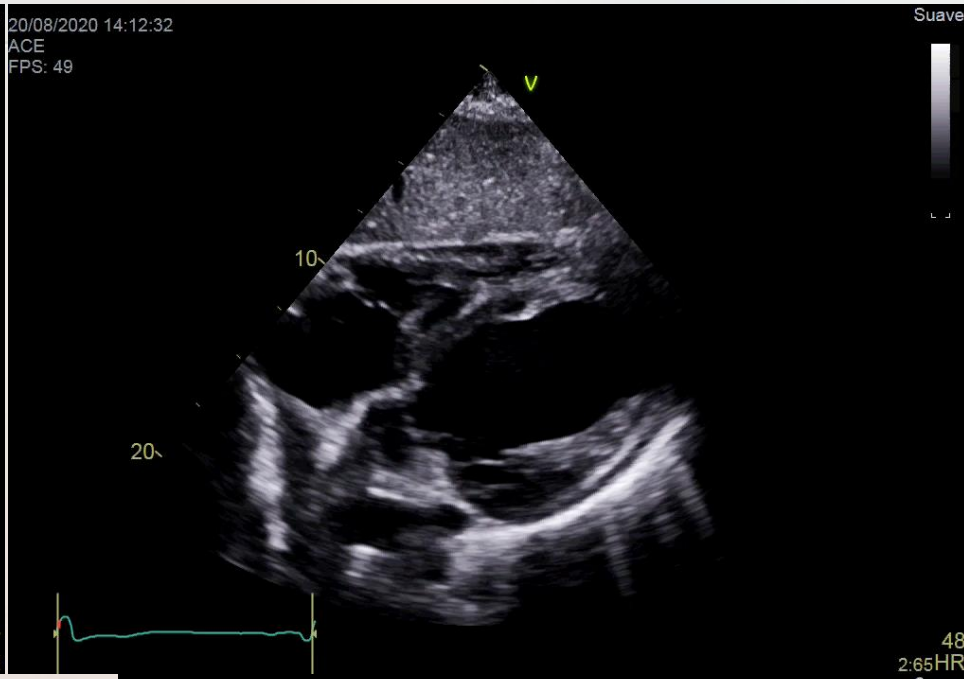


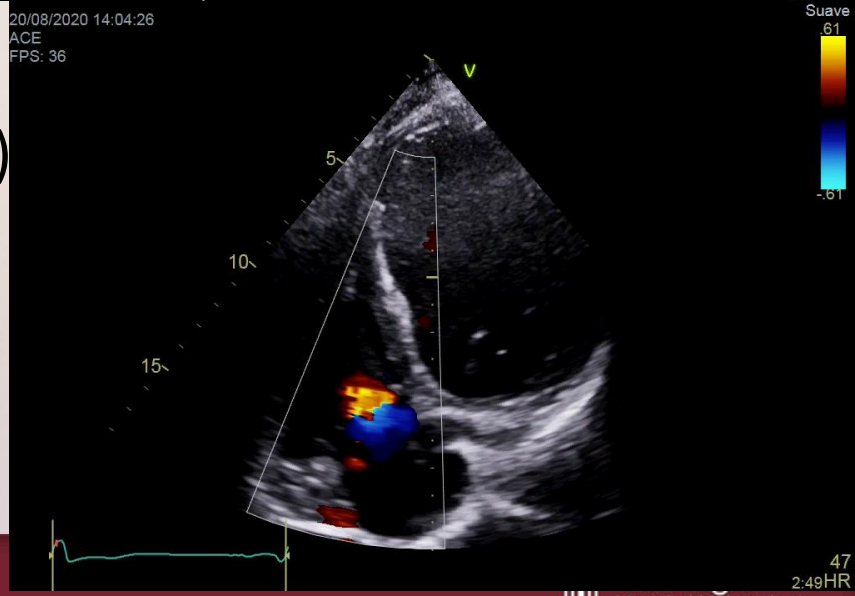


- LV (67 mm; 150 ml/m2), IVS:11 mm with LVEF=26%
- MR grade II, No AR, E/E':16 mm

Echocardiogram after iv diuretic







- RV slightly dilated (TA:38 mm, Baseline:48 mm, Midventricle:35 mm)
- Ratio RV/LV: 0.52, S/L RV: 0.6
- TAPSE:16 mm, S' of TA: 8 cm/s
- TR grade I with PAPs:51 mmHg
- Non dilated IVC, but poor mobility

Right heart Cath 14 days after levosimendan + 250 mg iv furosemide + hydroclorothiazide + Acetazolamide

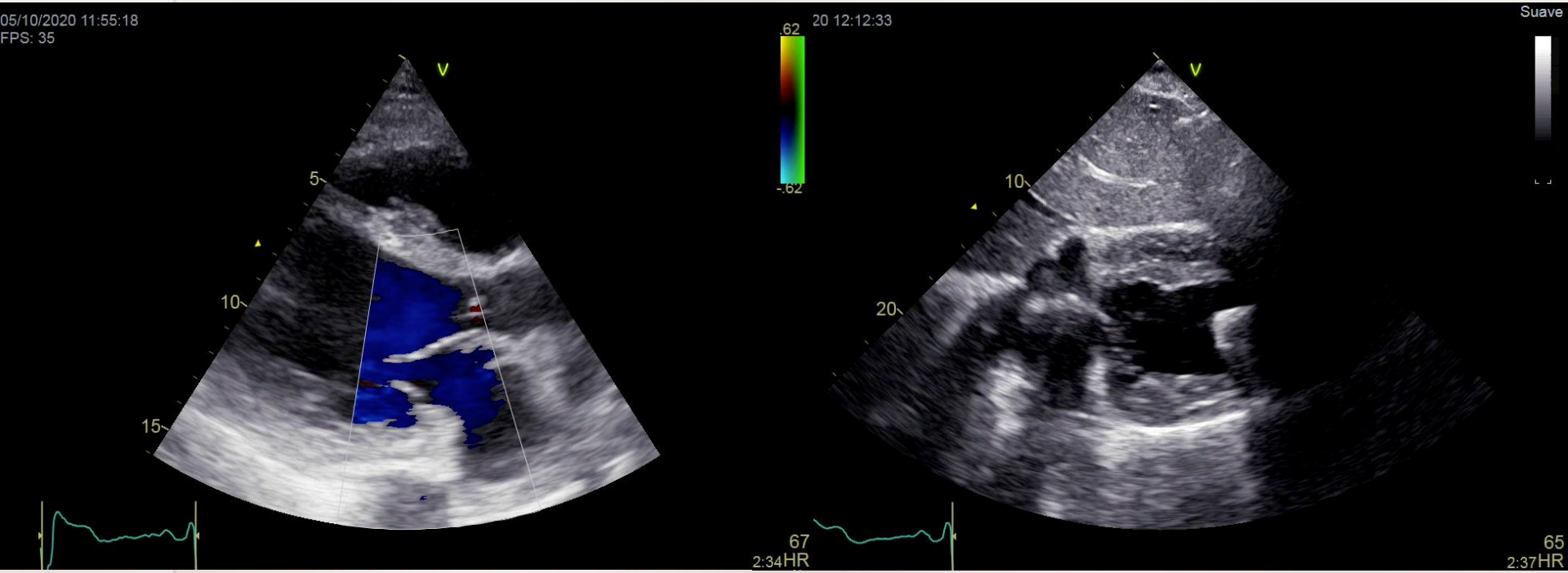
- BP: 94/70/57 mmHg, HR:55 bpm
- PAP:37/19/12 mmHg, Wedge:11 mmHg, CVP:4 mmHg, CO:3,5 l/min, CI:2 l/min/m^2, SVRI:2704
- TPG:8 mmHg, PVR:2,3 WU
- RVSWI:545 mmHg/ml/m2
- PAPi:6,25
- CVP/Wedge:0,36

EUROMACS-RHF Risk score
Score 0-2: Low risk
Score 2.5-4: Intermediate risk
Score > 4: High risk

LVAD implant

- Implant “dry” and NO post-implant
- Extubated in 24 hours and transitioned to Sildenafil 60 mg/8 h while DBT at 7-8 ug/kg/min
- LVAD 4900 rpm, giving 3,8-4 l/min
- Various episodes of AF treated with CV
- ARDS + haemoptysis: Heparin discontinued temporarily, no AAS. Improvement with prednisone 1 mg/kg
- Very slow inotrope weaning + diuretics.

Echocardiogram post-implant



LV dilated (67 mm) with LVEF=36% and mild MR. No AR
RV slightly dilated withTAPSE:15 mm, S':9 cm/s
Mild TR
IVC non-dilated and mobile

Discharge FC II NYHA BTT

- Lantus 20 IU/day + empaglifozine/Metformine
- OAC (INR:2-2,5) + AAS 100 mg
- Sildenafil 80 mg/8 h
- Furosemide 60 mg/day, reduced to 20 mg/day at 14d
- Eplerenone 50 mg/24 h
- Bisoprolol 1,25 mg/24 h, increased to 2,5 mg/day at 14d
- Sacubitril/Valsartan 49/51 mg/12 h
- Thyroxine 75 mcg/24 h
- Omega 3 acid 4 g/day
- Atorvastatin 40 mg/24 h
- LVAD: 5000 rpm, PI:3.1, Power:3.2 W, Flow:4.1 l/min

Conclusions

- Evaluation of the RV in the context of HF by echo provides useful information and is readily accessible but has important limitations
- MRI and CT may overcome some of these limitations
- Invasive hemodynamic evaluation of the PAP, PVR and RV function are still essential in the current management of patients with advanced HF in need for LVAD or HT

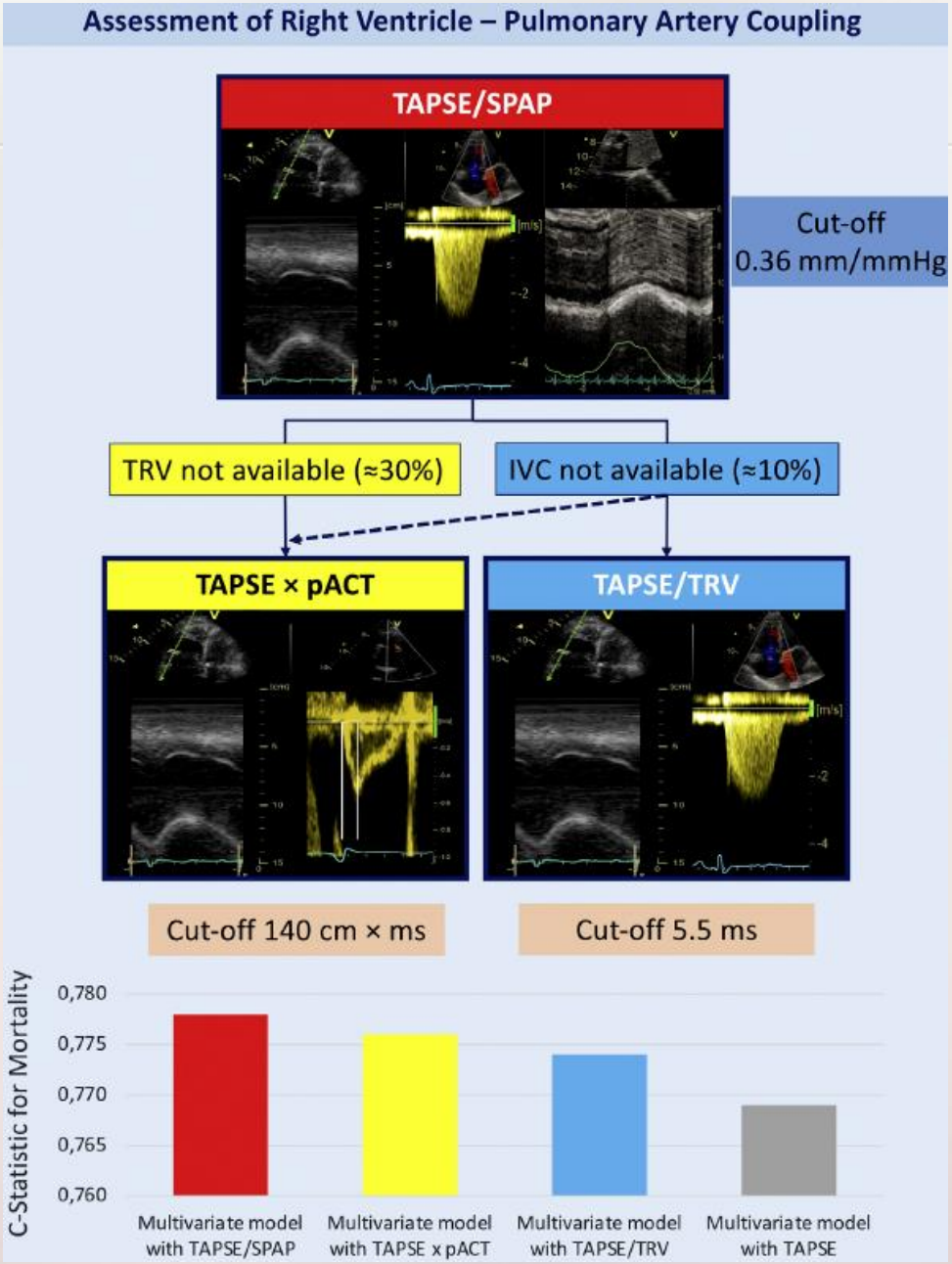
Generalitat de Catalunya
Departament de Salut

Institut Català de la Salut
Gerència Territorial
Metropolitana Sud

Bellvitge
Hospital Universitari

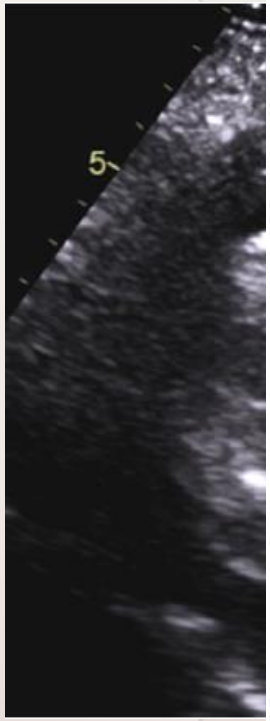
IDIBELL
Institut d'Investigació Biomèdica de Bellvitge

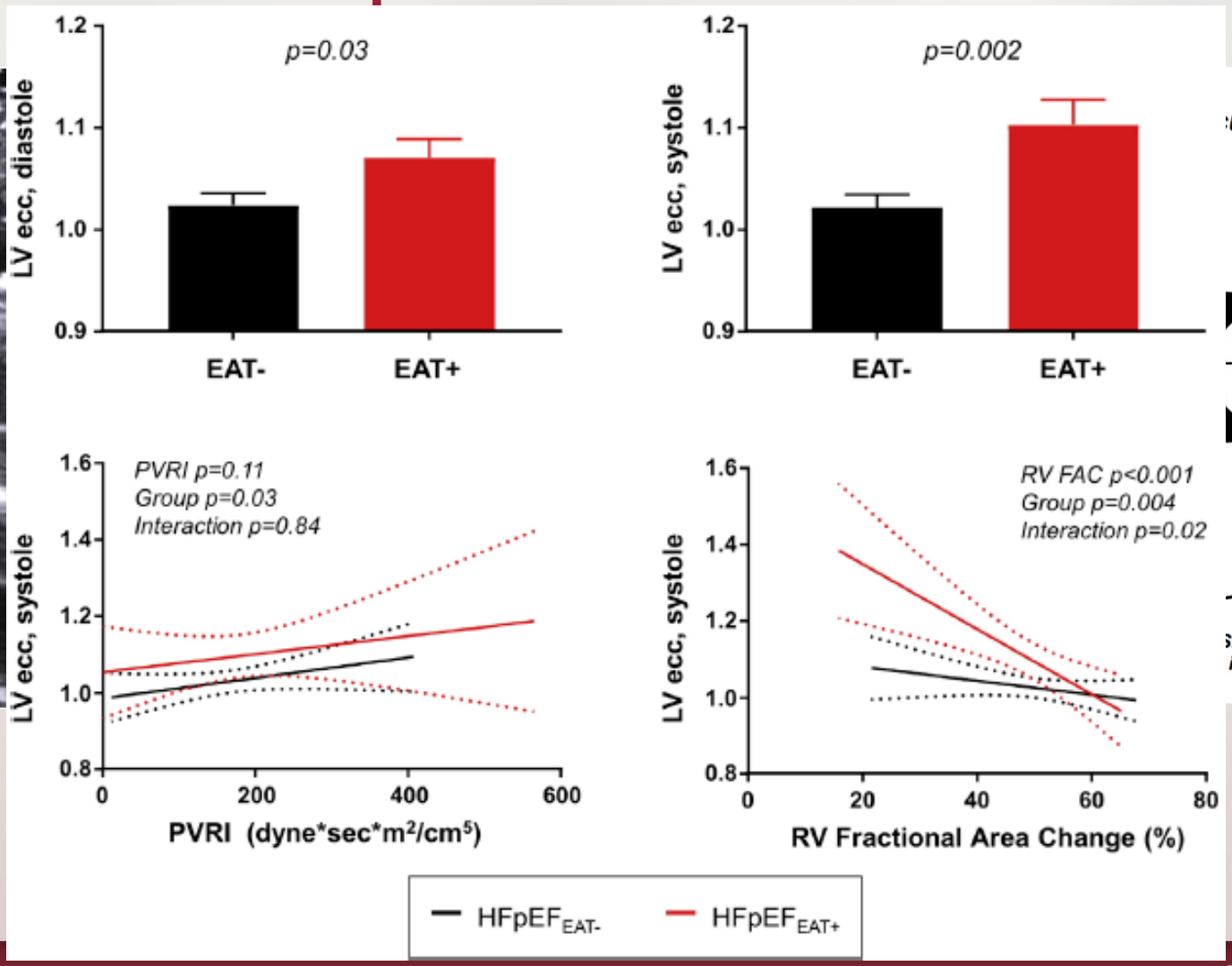
Universitat de Barcelona

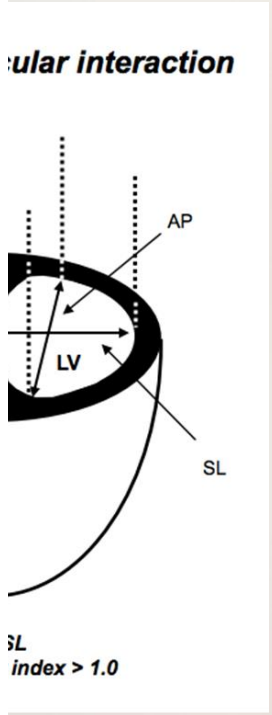


Pestelli G et al. Int J Cardiol 2021 in press

Role of epicardial fat excess (>9 mm) in obese patients with HFPEF







Koepp et al. JACC HF 2020;8:657