Definition, Classification, and Diagnosis of Pulmonary Hypertension

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TOTAL CME

mPAP > 20 mmHg

mPAP > 20 mmHg
PAWP ≤ 15 mmHg
PVR > 2 WU

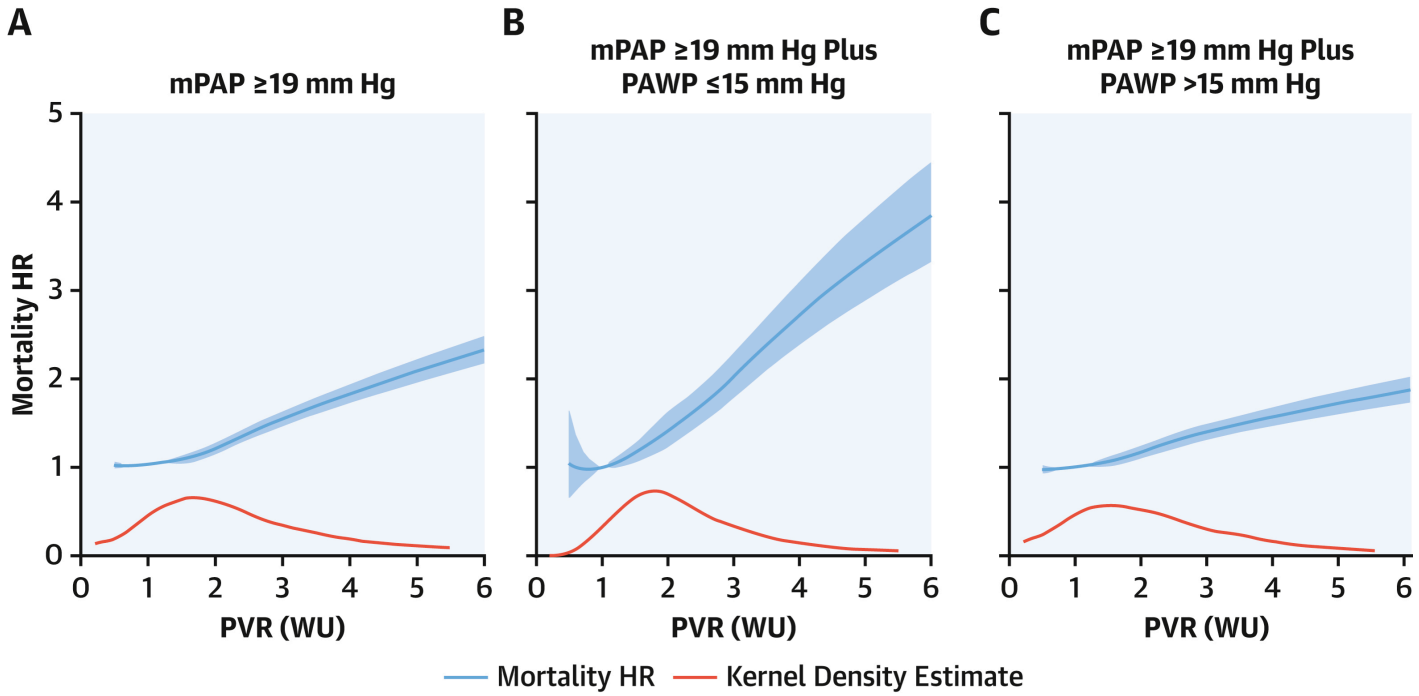
mPAP > 20 mmHg
PAWP > 15 mmHg
PVR ≤ 2 WU

mPAP > 20 mmHg
PAWP > 15 mmHg
PVR > 2 WU

mPAP/CO slope > 3 mmHg/L/min
between rest and exercise

Mild Pulmonary Hypertension and Mortality

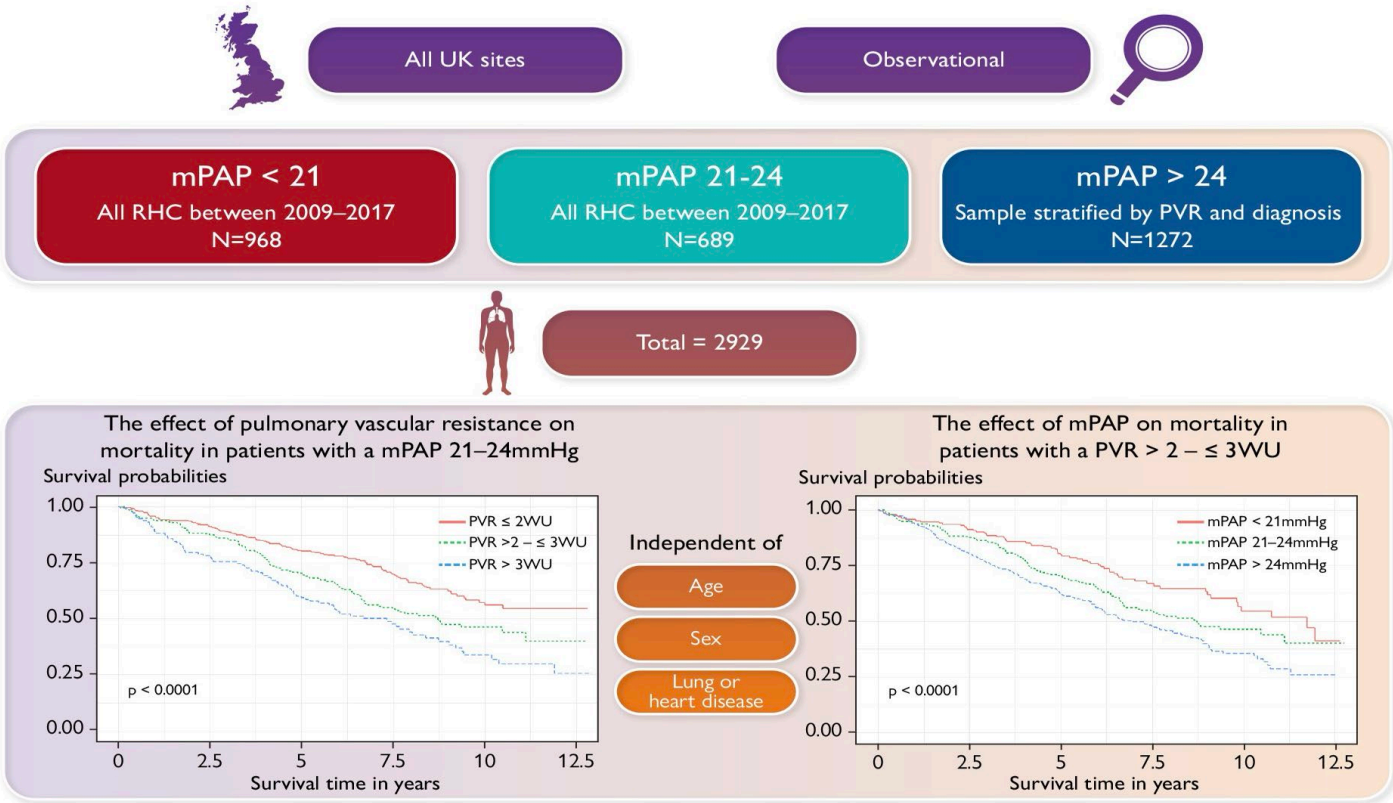
- Mild PH confers increased mortality in many well-phenotyped causes of PH (scleroderma, sickle cell, LHD)
- N = >40,000 VA patients, many with prevalent LHD
- PVR >2.1 captured ~55% more at-risk patients than a PVR of 3.0
- HR mortality 1.47
- HR heart failure hospitalization 1.17
- Results validated in a study at Vanderbilt University in a sex-matched cohort
- No data for treatment affecting this risk



Maron BA, et al. *Lancet Respir Med*. 2020;8(9):873-884.

Outcomes in Patients With “Mild PH”

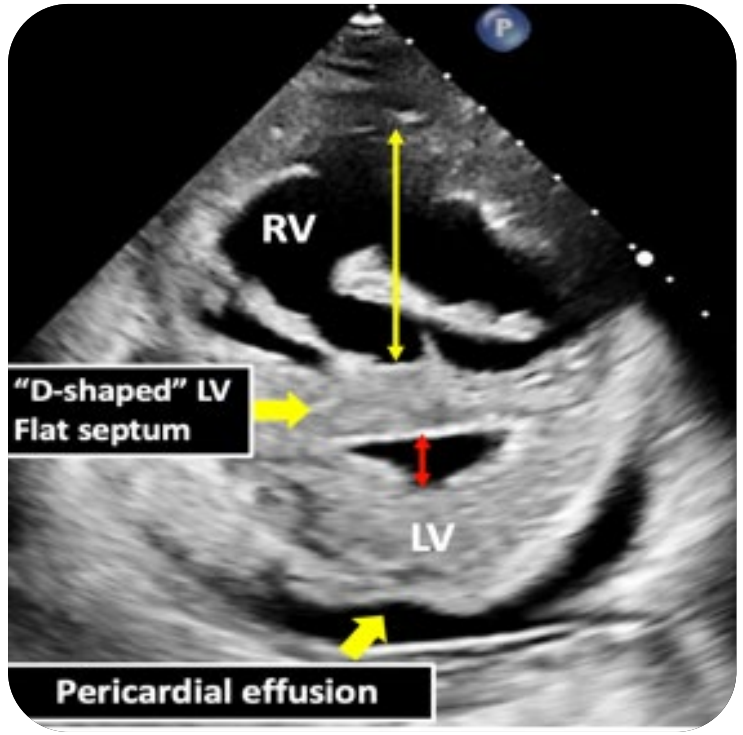
- Survival in patients referred for right heart cath in the UK 2009-2017, stratified by hemodynamics
- Majority of patients with mPAP 21-24 and PVR 2-3 had underlying heart or lung disease (68% and 79%, respectively)
- Mortality is increased in “mild PH”



Karia N, et al. *Eur Heart J*. 2023;44(44):4678-4691.

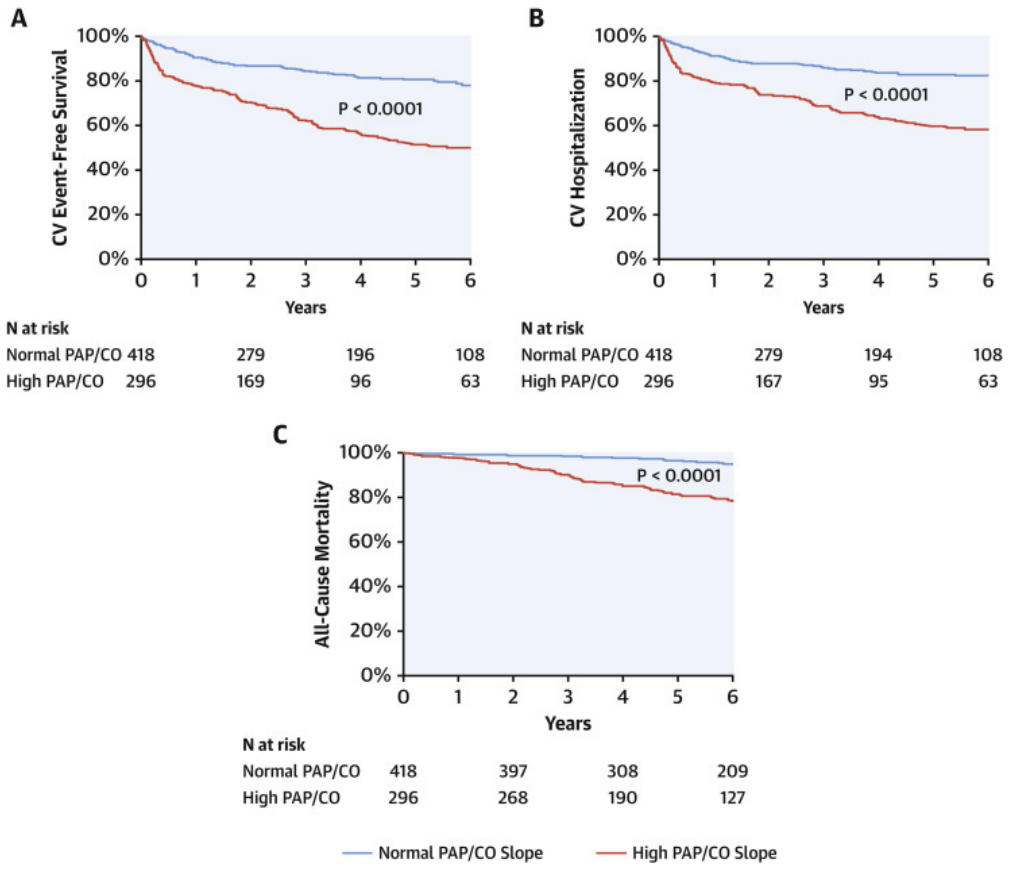
Mild PH and Classification

- Mild PH confers increased mortality in referred patients but often occurs in the setting of underlying heart and lung disease
- RHC must be interpreted in a clinical context to avoid misclassification
- Avoid RHC amidst an acute condition
- Comprehensive, deliberate evaluation remains important



Exercise Pulmonary Hypertension

- mPAP/CO slope > 3 mmHg/L/min is defined as abnormal
- Exercise PH is associated with worse event-free survival in patients with chronic dyspnea
- This finding holds despite comorbidities
- This definition allows future study of this population
- No proven therapeutic options



Ho JE, et al. *J Am Coll Cardiol*. 2020;75(1):17-26.

1. Pulmonary arterial hypertension (PAH)

1.1 Idiopathic
- 1.1.1 Long-term responders to calcium channel blockers

1.2 Heritable [a]
1.3 Associated with drugs and toxins [a]
1.4 Associated with:
- 1.4.1 Connective tissue disease
- 1.4.2 HIV infection
- 1.4.3 Portal hypertension
- 1.4.4 Congenital heart disease
- 1.4.5 Schistosomiasis

1.5 PAH with features of venous/capillary (PVOD/PCH) involvement
1.6 Persistent PH of the newborn

2. PH associated with left heart disease

2.1 Heart failure:
- 2.1.1 with preserved ejection fraction
- 2.1.2 with reduced or mildly reduced ejection fraction
- 2.1.3 with specific cardiomyopathies (hypertrophic and amyloid)

2.2 Valvular heart disease
- 2.2.1 aortic valve disease
- 2.2.2 mitral valve disease
- 2.2.3 mixed valvular disease

2.3 Congenital/acquired cardiovascular conditions leading to post-capillary PH

3. PH associated with lung diseases and/or hypoxia

3.1 Chronic obstructive pulmonary disease and/or emphysema
3.2 Interstitial lung disease
3.3 Combined pulmonary fibrosis and emphysema
3.4 Other parenchymal lung diseases [b]
3.5 Non-parenchymal restrictive diseases
- 3.5.1 Hypoventilation syndromes
- 3.5.2 Pneumonectomy
- 3.5.3 Musculoskeletal disorders

3.6 Hypoxia without lung disease (e.g. high altitude)
3.7 Developmental parenchymal disorders

4. PH associated with pulmonary artery obstructions

4.1 Chronic thrombo-embolic PH
4.2 Other pulmonary artery obstructions [c]

5. PH with unclear and/or multifactorial mechanisms

5.1 Haematological disorders [d]
5.2 Systemic disorders: sarcoidosis, pulmonary Langerhans's cell histiocytosis, and neurofibromatosis type 1
5.3 Metabolic disorders [e]
5.4 Chronic renal failure with or without haemodialysis
5.5 Pulmonary tumour thrombotic microangiopathy
5.6 Fibrosing mediastinitis
5.7 Complex congenital heart diseases

Long-Term Responders to Calcium Channel Blockers

Acute vasoresponder removed

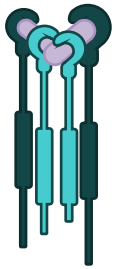
- A positive response is observed in up to 12% of iPAH or DT-PAH and 5% of heritable
- This group was the only one defined not by pathophysiology but by an initial therapeutic strategy
- This group includes both those who will be long-term responders and those who will progress similarly to PAH

Long-term responders added

- Separate pathophysiology and prognosis
- This does require long-term follow-up
- Emphasizes the importance of initial vasoreactivity testing

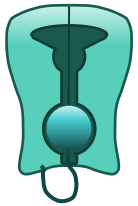
Genetic Abnormalities Associated With Heritable PAH

- IPAH, family hx of PH, anorexigen-associated PH, and CHD-PAH
- Genetic counseling
- Suspected PVOD/PCH



BMP/TGF-β family

ACVRL1 (ALK1)*
BMPR2 (BMPR2)
ENG (endoglin)*
GDF2 (BMP9)
SMAD9 (SMAD8)
CAV1 (caveolin-1)



Channels

ATP13A3 (ATPase 13A3)
KCNK3 (TASK1)
ABCC8 (MRP8)

Transcription factors

EIF2AK4 (GCN2)†
SOX17 (SOX17)‡
TBX4 (TBX4)‡

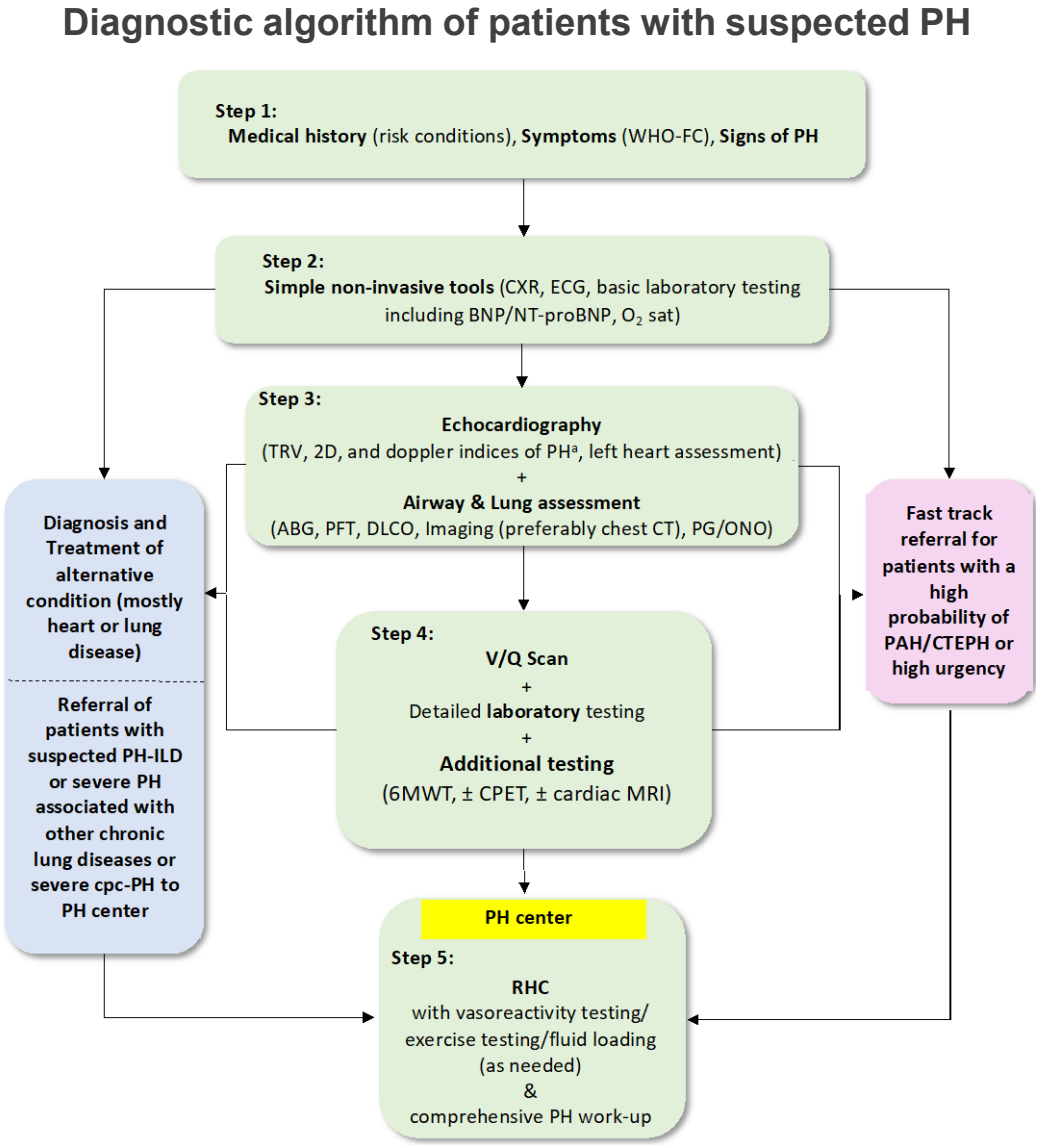
Other

KDR (VEGFR2)
TET2 (TET2)
GGCX (GGCX)

*Hereditary hemorrhagic telangiectasia. †Pulmonary veno-occlusive disease/pulmonary capillary hemangiomatosis.
‡Lung development abnormalities.
Eichstaedt CA, et al. *Eur Respir J*. 2023;61(2):2201471.

Diagnosis of Pulmonary Arterial Hypertension

- Simplified diagnostic algorithm
- Vasoreactivity testing in IPAH, DPAH, and HPAH
- Emphasize fast-track Referral for high-risk patients

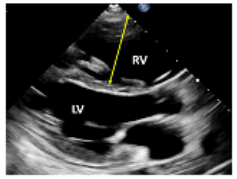


Echocardiographic Measurements

The ventricles	**RV/LV basal diameter / area ratio > 1.0**
	Flattening of interventricular septum (LVEI > 1.1 in systole and/or diastole)
	TAPSE / sPAP ratio < 0.55 mm/mmHg
Pulmonary artery	RVOT AT < 105 ms and/or mid-systolic notching
	Early diastolic pulmonary regurgitation velocity > 2.2 m/s
	PA diameter > AR diameter; PA diameter > 25 mm
Inferior vena cava and right atrium	IVC diameter > 21 mm with decreased inspiratory collapse
	RA area (end-systole) > 18 cm^2

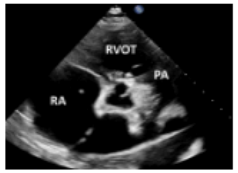
Echocardiographic Measurements by Standard View

Parasternal Long Axis

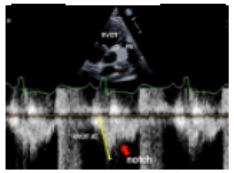


Enlarged RV

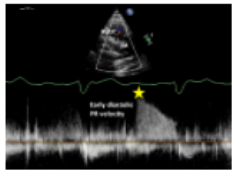
Parasternal Short Axis (at level of valves)



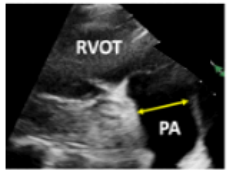
Enlarged RA, RVOT, and PA



Decreased RVOT/PV acceleration time <105 ms with mid-systolic notch

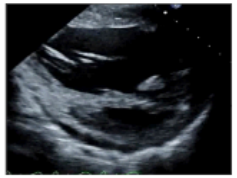


Increased peak diastolic pulmonic regurgitant velocity >2.2 m/s



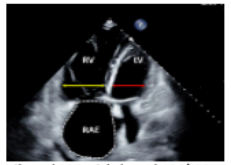
Enlarged PA >25 mm

Parasternal Short Axis (at mid-ventricle)

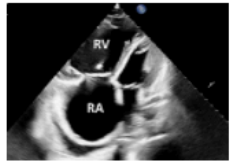


D-Shaped LV; Decreased LV eccentricity index (LVEI, D2/D1) >1; Pericardial effusion

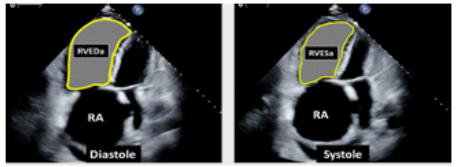
4-Chamber View



Dilated RV with basal RV/LV ratio > 1.0; Enlarged right atrial area (RAE) >18cm² (end-systole)

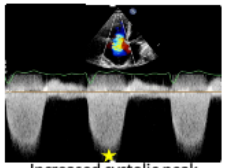


Pericardial effusion

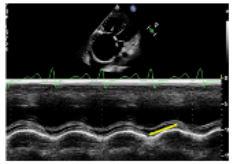


Reduced RV fractional area change (FAC) in systole versus diastole [(RVEDa-RVESa)/RVEDV] <35%

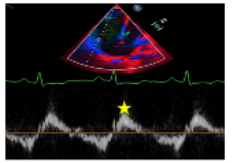
4-Chamber View (Doppler and M-Mode)



Increased systolic peak tricuspid regurgitant velocity >2.8 m/s by Doppler

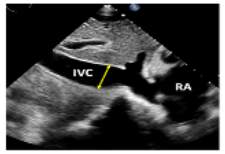


Decreased tricuspid annular plane excursion (TAPSE) <1.8cm by M-mode



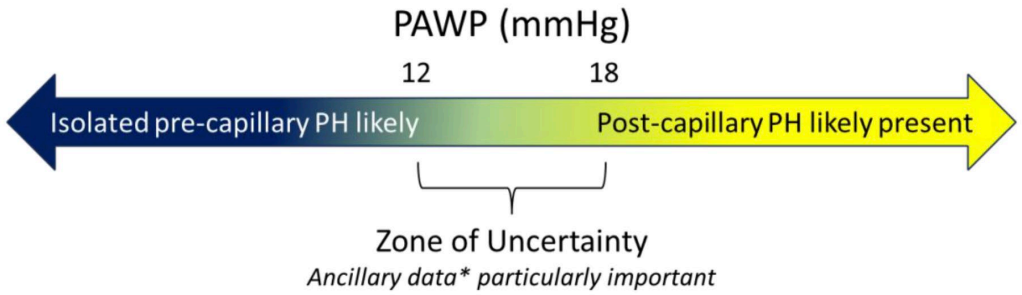
Decreased systolic excursion velocity (S') of tricuspid valve annulus <9.5 cm/s by tissue Doppler imaging

IVC

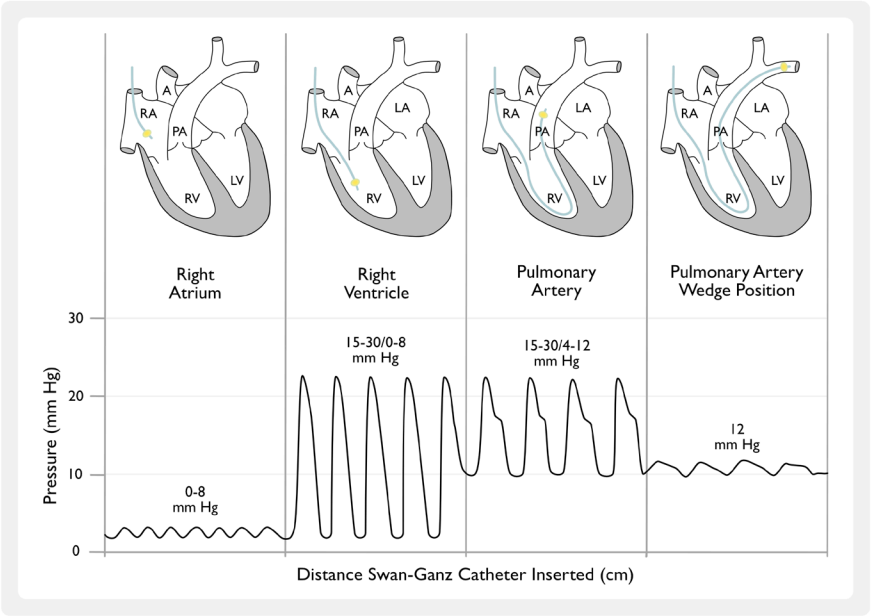


Distended IVC >2.1 cm with diminished inspiratory collapsibility (<50% with a sniff or <20% with quiet inspiration)

Right Heart Catheterization



Swan-Ganz Distal Tip Position and Expected Pressure Waveforms



Measurements are end-expiratory without breath-hold or averaged over 3-4 respiratory cycles

Direct Fick > TD > Indirect Fick CO

Vasoreactivity testing in IPAH, DPAH, and HPAH

Normal or moderately increased mPAP and PCWP 13-15 may benefit from provocative testing

Exercise

- Exercise PH defined by the mPAP/CO slope > 3 mmHg/L/min, but may also bring out postcapillary PH

Patient Case

- 15-year-old male patient with dyspnea and chest pain
- Born 3.5 weeks premature and spent 6 days in NICU for “lung problems”
- Struggling with dyspnea and fatigue with exercise since age 9
- Diagnosed with asthma but inhalers did not help; CT with air trapping
- He recently developed chest pain that radiates to left shoulder and a decline in exercise capacity
- TTE with right-to-left shunt through a patent foramen ovale
- He is also having a problem with his knee and is asking to undergo knee surgery

Past medical history

- ADHD – on lisdexamfetamine
- Factor V Leiden heterozygote

Social history

- Has smoked marijuana and a few cigarettes in high school; no cocaine or methamphetamine

Family history

- Biological father was a long-distance truck driver who had PE and died at age 33

Patient Case

- HRCT chest
- Mosaic attenuation bilaterally on expiratory phase
- Mild diffuse bronchial wall thickening and bronchiectasis
- Mildly enlarged main pulmonary artery

Pulmonary function tests

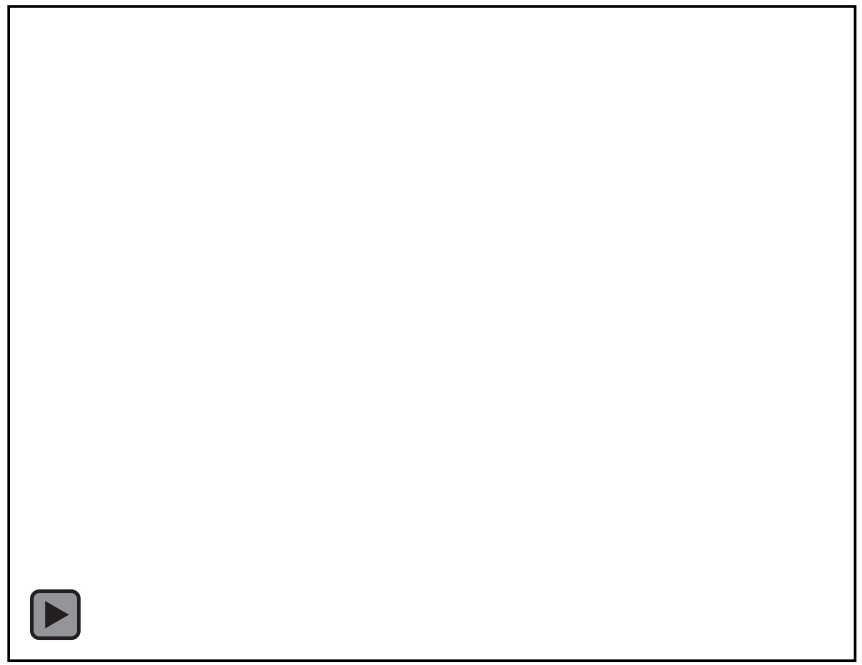
- FVC 3.71 (87 %)
- FEV1 3.08 (84 %)
- Ratio 83%
- TLC 4.62 (89 %)
- DLCO normal

NT-proBNP

- 58 pg/mL

Cardiac MRI

- RVEDV 219 ml
- RVEF 61 %
- SVI 64 ml/m^2



RHC (3/22/19)

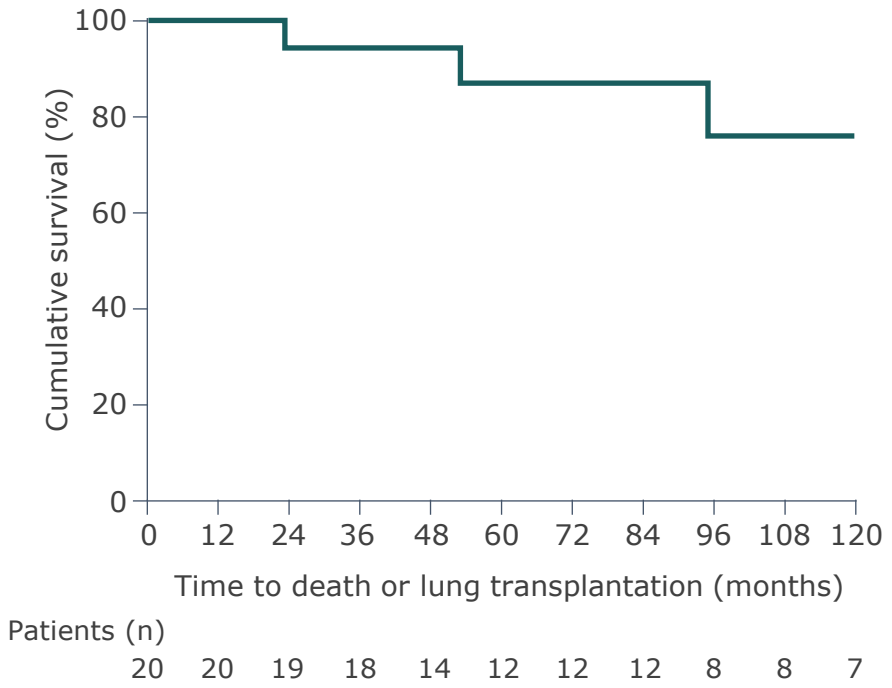
- RAP 7 mmHg
- PAP 62/45 (52) mmHg
- PCWP 9 mmHg
- Qp 2.28; Qs 2.28; Qp/Qs 1:1
- PVR 18.8 WU
- PA sats 67%
- SVC 65%
- RA 66%

DLCO, diffusing capacity of the lungs for carbon monoxide; FEV1, forced expiratory volume; FVC, forced vital capacity; HRCT, high-resolution computed tomography; MRI, magnetic resonance imaging; NT-proBNP, N-terminal pro-brain natriuretic peptide; PA(P), pulmonary artery (pressure); PCWP, pulmonary capillary wedge pressure; PVR, pulmonary vascular resistance; Qp/Qs, ratio of pulmonary blood flow to systemic blood flow; RA(P), right atrial (pressure); RHC, right heart catheterization; RVEDV, right ventricle end diastolic volume; RVEF, right ventricle ejection fraction; SVC, superior vena cava; SVI, stroke volume index; TLC, total lung capacity; WU, Wood units.

Patient Case: Genetic Testing

- Heterozygous in frameshift mutation in exon 9 of the ***TBX4*** **gene**; the new reading frame encodes a STOP codon 14 positions downstream
  - Associated with childhood-onset PAH, small patella syndrome (ischiocoxopodopatellar syndrome), and pulmonary parenchymal abnormalities

Time to death or lung transplantation in patients with PAH with *TBX4* mutation



Thoré P, et al. *Eur Respir J.* 2020;55(5):1902340.

Risk Stratification in PAH

State of the Art

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TOTAL CME

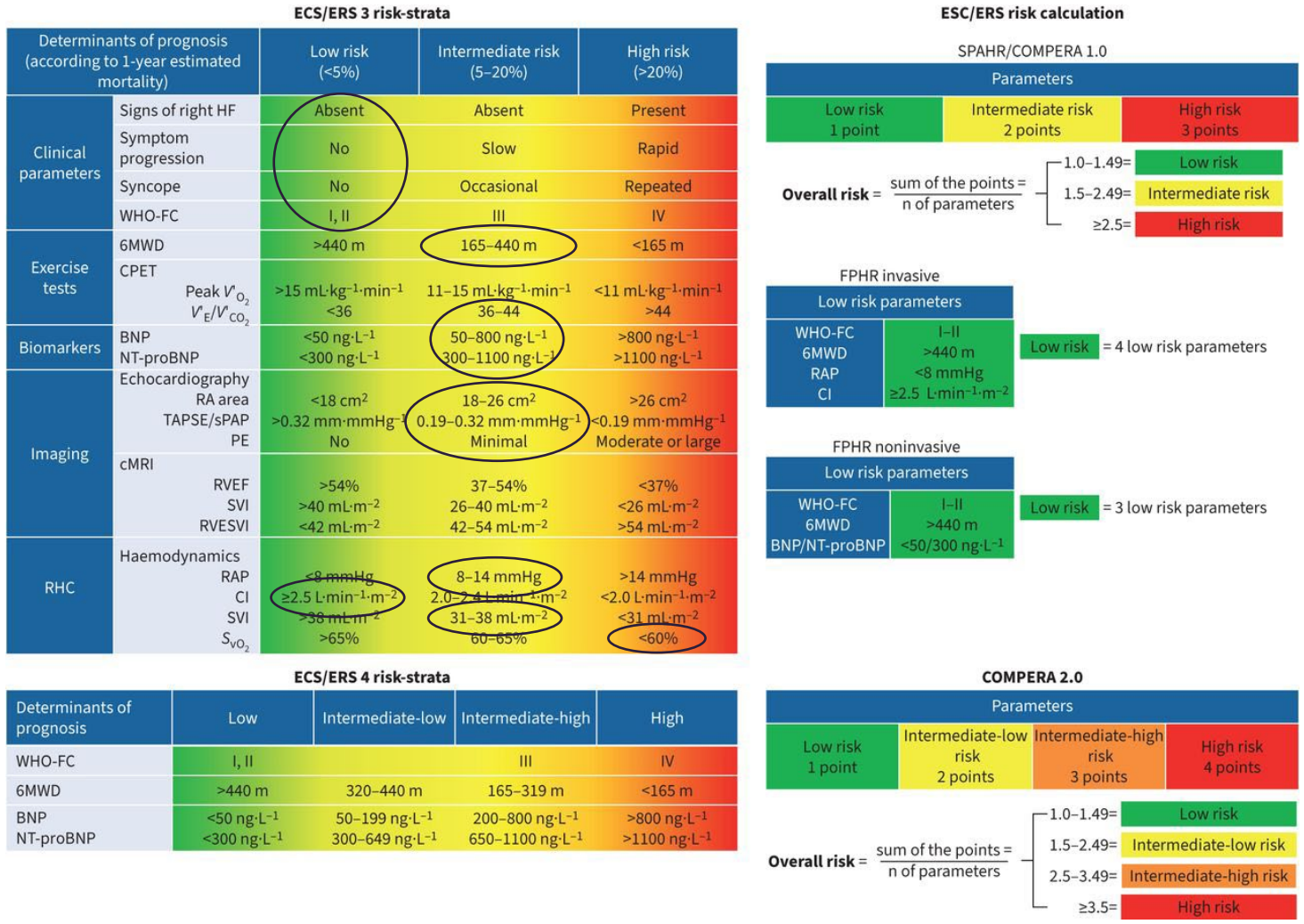
59-Year-Old Woman With Mild Dyspnea

- Family history:
  - Grandmother died in childbirth in the 1930s
  - 7 years ago, her daughter underwent transplant for PAH
- Past medical history:
  - Obstructive sleep apnea
  - Rheumatoid arthritis x 25 years
    - Rx hydroxychloroquine, etanercept, prednisone
- Exam: BP 102/80, P 87, BMI 31, JVP nl, prominent P2
- Echo: eRVSP 65 mmHg, D-shaped LV, mod RV enlarge/dysfn, nl IVC
- Cardiac MRI: RVEF 41%
- PFTs: Normal spirometry, DLCO 74% predicted
- 6-min walk: 317 m, normal sats
- BNP: 280 pg/mL

Right Heart Catheterization

- BP 102/80, P 87
- RA 9, PA 72/27/44, PCW 8, CO/CI 4.8/2.9, PVR 9 WU, PA sat 59%, SVI 33
- Nitric oxide:
  - PA 72/27/44, PCW 6, CO/CI 5.0/3.0, PVR 7.6 WU
- Dx: PAH, familial and/or related to rheumatoid arthritis
- Next step: Risk stratification
- Key point: Baseline *and serial* (3- to 6-month interval) reassessments

European Society of Cardiology (ESC)/European Respiratory Society (ERS) Risk Tools



ECS/ERS 3 risk-strata

Determinants of prognosis (according to 1-year estimated mortality)		Low risk (<5%)	Intermediate risk (5–20%)	High risk (>20%)
Clinical parameters	Signs of right HF	Absent	Absent	Present
	Symptom progression	No	Slow	Rapid
	Syncope	No	Occasional	Repeated
	WHO-FC	I, II	III	IV
Exercise tests	6MWD	>440 m	165–440 m	<165 m
	CPET			
	Peak V'_{O_2}	>15 mL·kg^{-1}·min^{-1}	11–15 mL·kg^{-1}·min^{-1}	<11 mL·kg^{-1}·min^{-1}
	V'_E/V'_{CO_2}	<36	36–44	>44
Biomarkers	BNP	<50 ng·L^{-1}	50–800 ng·L^{-1}	>800 ng·L^{-1}
	NT-proBNP	<300 ng·L^{-1}	300–1100 ng·L^{-1}	>1100 ng·L^{-1}
Imaging	Echocardiography			
	RA area	<18 cm^2	18–26 cm^2	>26 cm^2
	TAPSE/sPAP	>0.32 mm·mmHg^{-1}	0.19–0.32 mm·mmHg^{-1}	<0.19 mm·mmHg^{-1}
	PE	No	Minimal	Moderate or large
	cMRI			
	RVEF	>54%	37–54%	<37%
	SVI	>40 mL·m^{-2}	26–40 mL·m^{-2}	<26 mL·m^{-2}
	RVESVI	<42 mL·m^{-2}	42–54 mL·m^{-2}	>54 mL·m^{-2}
RHC	Haemodynamics			
	RAP	<8 mmHg	8–14 mmHg	>14 mmHg
	CI	≥2.5 L·min^{-1}·m^{-2}	2.0–2.4 L·min^{-1}·m^{-2}	<2.0 L·min^{-1}·m^{-2}
	SVI	>38 mL·m^{-2}	31–38 mL·m^{-2}	<31 mL·m^{-2}
	S_{vO_2}	>65%	60–65%	<60%

ECS/ERS 4 risk-strata

Determinants of prognosis	Low	Intermediate-low	Intermediate-high	High
WHO-FC	I, II		III	IV
6MWD	>440 m	320–440 m	165–319 m	<165 m
BNP	<50 ng·L^{-1}	50–199 ng·L^{-1}	200–800 ng·L^{-1}	>800 ng·L^{-1}
NT-proBNP	<300 ng·L^{-1}	300–649 ng·L^{-1}	650–1100 ng·L^{-1}	>1100 ng·L^{-1}

ESC/ERS risk calculation

SPAHR/COMPERA 1.0

Parameters		
Low risk 1 point	Intermediate risk 2 points	High risk 3 points

Overall risk = sum of the points / n of parameters
- 1.0–1.49= Low risk
- 1.5–2.49= Intermediate risk
- ≥2.5= High risk

FPHR invasive

Low risk parameters	
WHO-FC	I–II
6MWD	>440 m
RAP	<8 mmHg
CI	≥2.5 L·min^{-1}·m^{-2}

Low risk = 4 low risk parameters

FPHR noninvasive

Low risk parameters	
WHO-FC	I–II
6MWD	>440 m
BNP/NT-proBNP	<50/300 ng·L^{-1}

Low risk = 3 low risk parameters

COMPERA 2.0

Parameters			
Low risk 1 point	Intermediate-low risk 2 points	Intermediate-high risk 3 points	High risk 4 points

Overall risk = sum of the points / n of parameters
- 1.0–1.49= Low risk
- 1.5–2.49= Intermediate-low risk
- 2.5–3.49= Intermediate-high risk
- ≥3.5= High risk

Dardi F, et al. *Eur Respir J*. Published online August 29, 2024. doi:10.1183/13993003.01323-2024

Registry to Evaluate Early and Long-Term Pulmonary Arterial Hypertension Disease Management (REVEAL) Risk Tools

REVEAL 2.0

	−2	−1	0	1	2	3
WHO group 1 subgroup			Other	CTD	Heritable	PoPH
Male >60 years			No		Yes	
All-cause hospitalisation ≤6 months			No	Yes		
eGFR <60 mL/min/1.73m² or renal insufficiency			No	Yes		
Systolic BP (mmHg)			≥110	<110		
Heart rate (bpm)			≤95	>95		
WHO-FC		I	II	III	IV	
6MWD (m)	≥440	320–440	165–320	<165		
BNP (ng·L⁻¹) or NT-proBNP (ng·L⁻¹)	<50 <300		50–200 300–1100	200–800	≥800 ≥1100	
PE on echocardiogram			No	Yes		
D_{LCO} ≤40 % pred			No	Yes		
RAP >20 mmHg within 1 year			No	Yes		
PVR <5 WU		Yes	No			

Overall risk= sum of the points +6 =
- 0–6= Low risk
- 7–8= Intermediate risk
- ≥9= High risk

Total = 10

REVEAL Lite 2

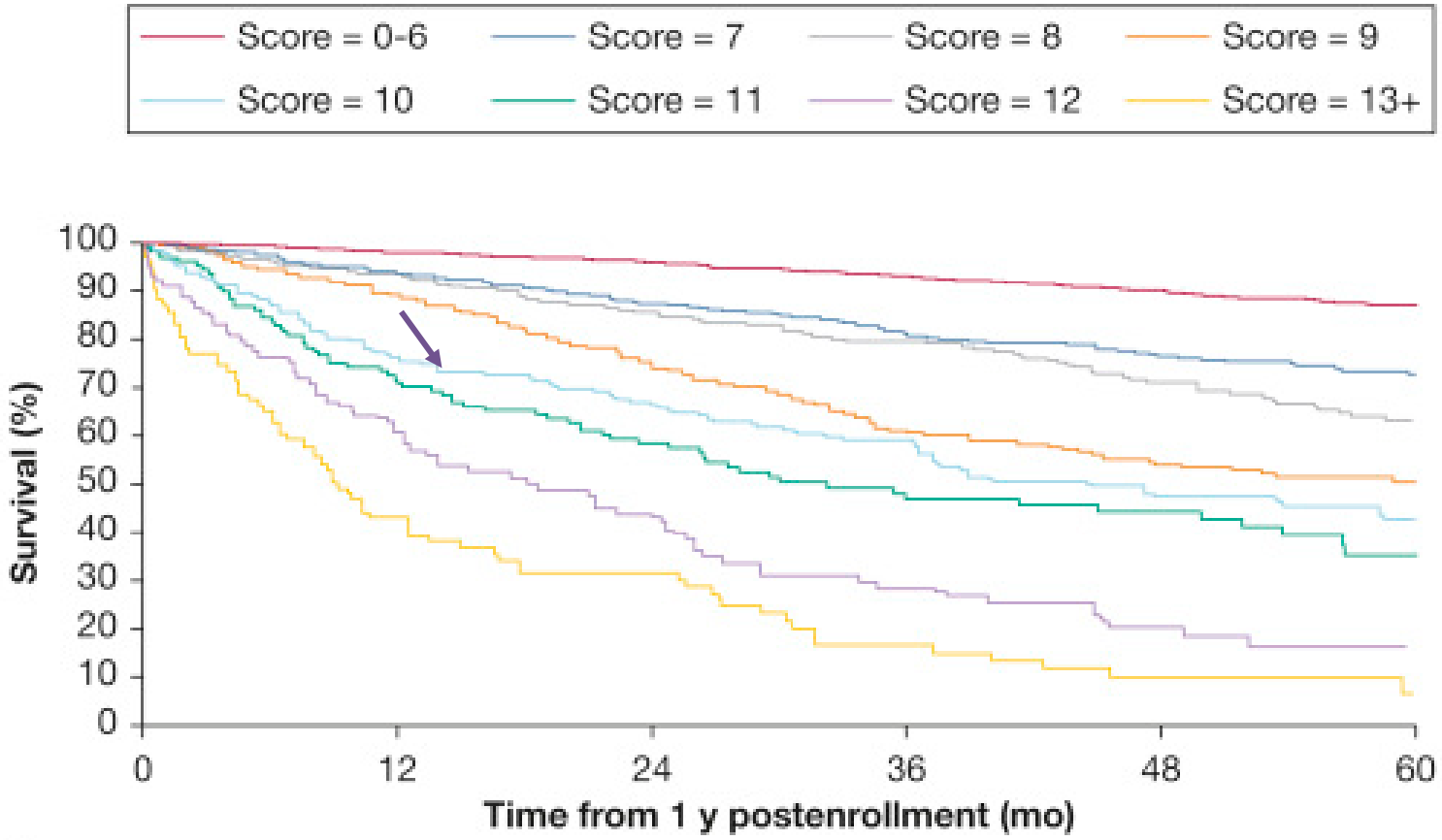
	−2	−1	0	1	2
eGFR <60 mL/min/1.73m² or renal insufficiency			No	Yes	
Systolic BP (mmHg)			≥110	<110	
Heart rate (bpm)			≤95	>95	
WHO-FC		I	II	III	IV
6MWD (m)	≥440	320–440	165–320	<165	
BNP (ng·L⁻¹) or NT-proBNP (ng·L⁻¹)	<50 <300		50–200 300–1100	200–800	≥800 ≥1100

Overall risk= sum of the points +6 =
- 0–5= Low risk
- 6–7= Intermediate risk
- ≥8= High risk

Total = 8

Modified from Dardi F, et al. *Eur Respir J*. Published online August 29, 2024. doi:10.1183/13993003.01323-2024

REVEAL 2.0 5-Year Survival Curves

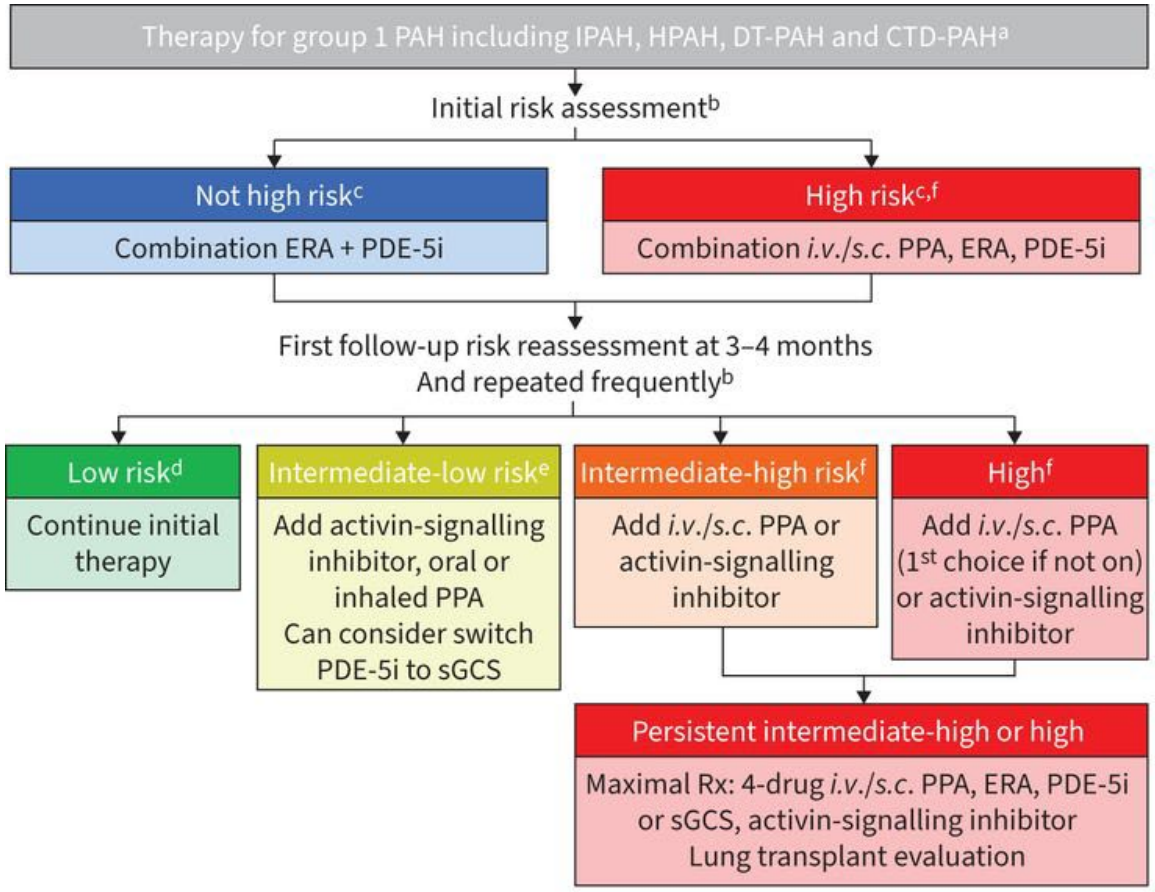


Benza RL, et al. *Chest*. 2019;156(2):323-337.

Attributes/Limitations of Risk Calculators

- Greater number of variables in REVEAL 2.0, REVEAL 2.0 Lite improves performance, but does not prove that using them results in better patient outcome than using the other tools
- Accounting for patient-specific factors, such as diagnosis, age, sex, DLCO, renal function, provides more precise prognostication
- Some components of the calculators may be impacted by factors other than the severity of the PAH, so may not be modified by more therapy
- Noninvasive calculators are easier to obtain than those that include invasive parameters, but hemodynamics are a critical aspect of PAH
- Calculators have mostly been built using databases with little imaging data, restricting their ability to incorporate that additional information

Treatment Algorithm

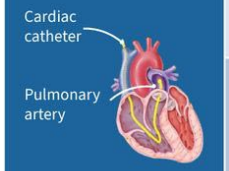


Treatment algorithm key points

a. The treatment algorithm is intended for patients with confirmed group 1 PAH (phenotypically clear-cut, including **mPAP ≥25 mmHg and PVR >3 Wood Units** and no significant response on acute vasoreactivity testing). See text for treatment in PAH with complex phenotypes.
b. ***Risk assessment*** should be performed at baseline, within 3–4 months and periodically thereafter, and using FC, 6MWD and natriuretic peptides as a part of a validated risk calculator. Haemodynamics, RV imaging and other measures should be used to supplement risk assessment.
c. ***Initial triple therapy*** with an *i.v./s.c.* PPA is recommended in high-risk patients and may be considered in non-high risk with severe haemodynamics and/or poor RV function.
d. Most ***low-risk patients*** at follow-up should continue initial therapy.
e. Clinical trials with oral and inhaled treprostinil included ***only patients on monotherapy***, while studies of selexipag and sotarcept included patients on combination therapy.
f. ***Transplant referral*** should be considered for select high-risk patients at diagnosis, and for intermediate-high and high-risk patients at first or subsequent follow-up.

Chin KM, et al. *Eur Respir J*. Published online August 29, 2024. doi:10.1183/13993003.01325-2024

Comprehensive Treatment Goals in Pulmonary Arterial Hypertension (PAH)

Domain	Treatment goals	Comments	Limitations
Exercise tolerance 	**6MWD >440 m** **WHO-FC I or II**	Not disease-specific, potentially affected by conditions other than PAH	Goals may not be achievable in patients with other conditions limiting exercise capacity
RV function and strain 	**BNP <50 ng·L^{-1}** **NT-proBNP <300 ng·L^{-1}**	Not disease-specific, potentially affected by conditions other than PAH	Goals may not be achievable in patients with interfering conditions
	Need for research prioritisation: RA area <18 cm^2 TR, none or trace TAPSE/sPAP >0.32 mm·mmHg^{-1}	Other imaging parameters from echocardiography and MRI are emerging	TAPSE/sPAP threshold requires further validation
Haemodynamics 	**RAP <8 mmHg** **CI ≥2.5 L·min^{-1}·m^{-2}** **SVI >37 mL·m^{-2}** **S_{vO_2} >65%** **PVR <5 WU**	Uncertain added value in low-risk patients according to ESC/ERS 4 strata model PVR <5 WU treatment goal may not apply to patients with congenital heart disease	Established prognostic value; however, not necessarily independent of noninvasive parameters
	Need for research prioritisation: mPAP <30–35 mmHg PAC ≥2.5 mL·mmHg^{-1}	With emerging therapies and effective combination treatment strategies, comprehensive haemodynamic assessment of treatment response is expected to play a prominent role in the management of patients with PAH	The proposed thresholds may be associated with long-term survival; however, this is not evidence-based and requires further validation

Dardi F, et al. *Eur Respir J*. Published online August 29, 2024. doi:10.1183/13993003.01323-2024

Limitations of Risk Assessment Tools

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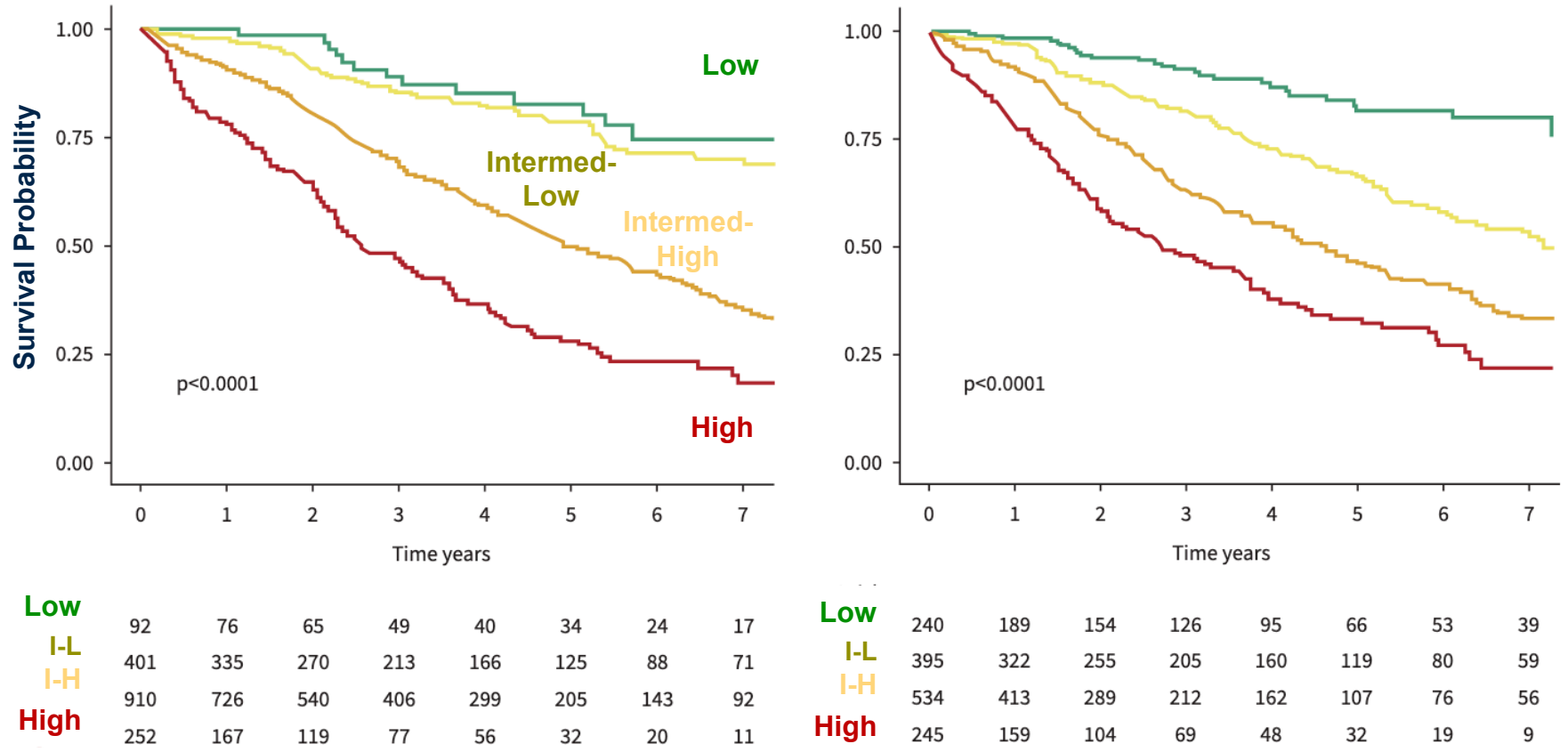
TOTAL CME

REVEAL 2.0 and Lite 2 Risk Score

Parameter	REVEAL 2.0 (13 variables)			REVEAL Lite 2 (6 variables)
Cause	CTD-PAH: +1	PoPH: +3	Heritable: +2	-
Demographics	Men >60 y: +2			-
Renal Insufficiency	eGFR <60 mL/min/1.73 m^2 or defined by clinical judgment if eGFR not available: +1			✓
NYHA or WHO FC	FC I: −1	FC III: +1	FC IV: +2	✓
All-Cause Hospitalization	Within previous 6 mo: +1			-
Vital Signs	SBP <110 mmHg: +1	HR >96 bpm: +1		✓✓
6MWD	≥440 m: −2	320 to <440 m: −1	<165 m: +1	✓
BNP (or NT-proBNP)	<50 pg/mL (< 300 pg/mL): −2	200 to <800 pg/mL: +1	≥800 pg/mL (≥1100 pg/mL): +2	✓
Echocardiogram	Pericardial effusion: +1			-
PFT	% predicted DLCO <40%: +1			-
RHC Within 1 y	mRAP ≥20 mmHg: +1	PVR <5 Wood units: −1		-
Total Score	Sum of above +6			✓

Adapted from Benza RL, et al. *Chest.* 2021:159(1):337-346.

COMPERA 2.0: Refined 4-Stratum Risk Assessment Model



Intermediate-low / intermediate-high 4-stratum model more sensitive to prognostically relevant changes in risk than original 3-stratum with 1 intermediate category.

Hoeper MM, et al. *Eur Respir J*. 2022;60(1):2102311.

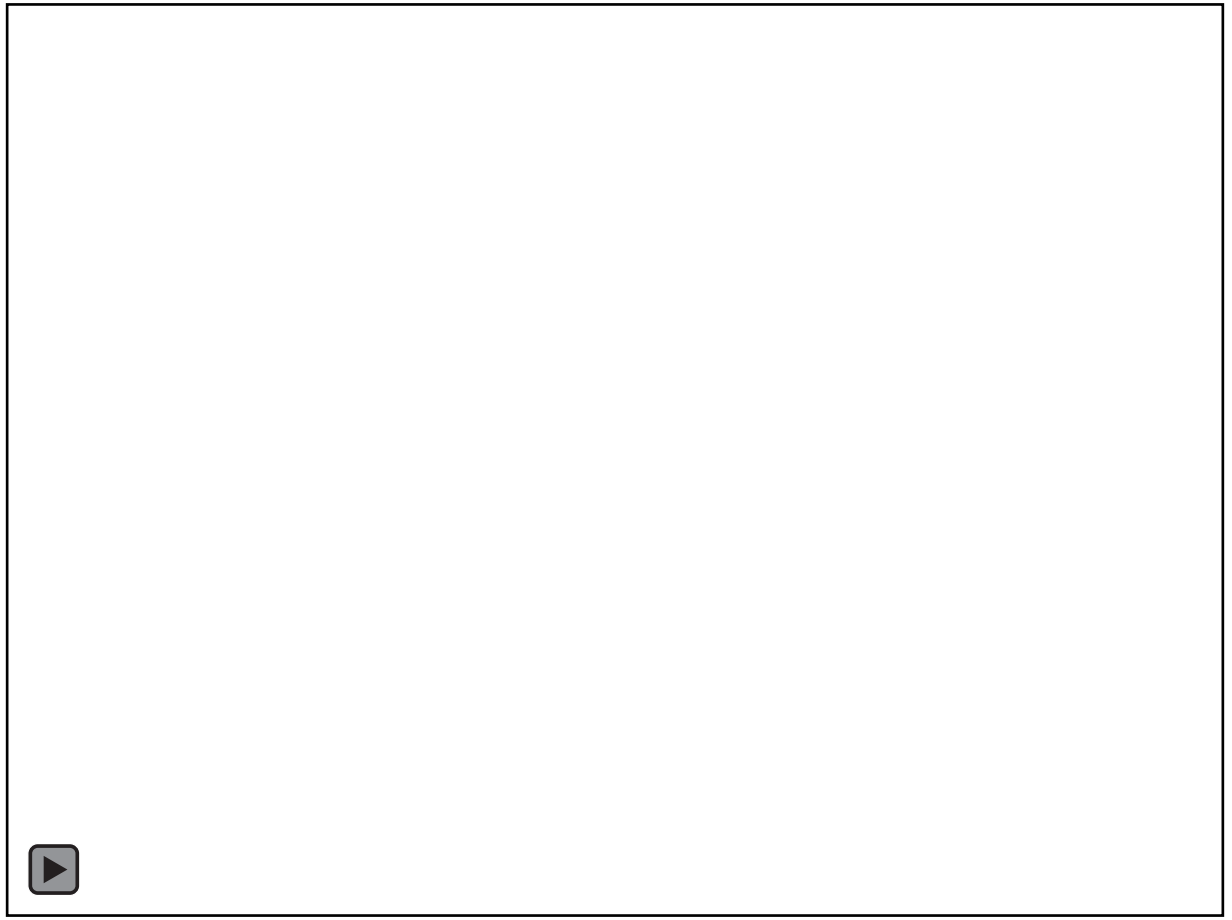
2 Ends of the Spectrum

- Younger patients who function well despite advanced hemodynamics and poor RV function
- Patients who are older or have multiple comorbidities who function poorly despite mild pulmonary vascular disease

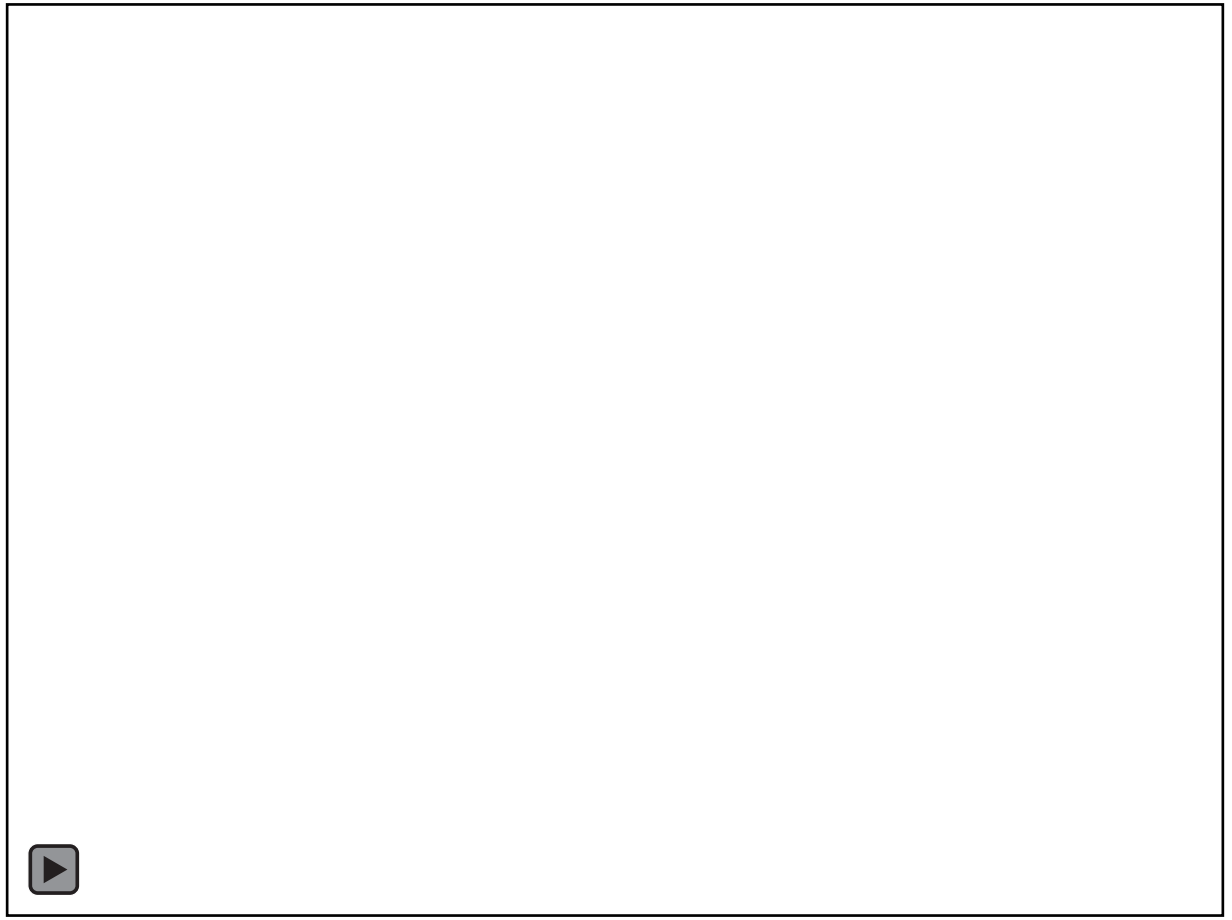
Patient LB

- 45 yo woman with 5-year h/o IPAH, triple therapy
  - Epo at 44 ng/kg/min, tadalafil, macitentan
- Right heart cath 11/22
  - mPAP 81 mmHg, RAP 7, PCWP 14
  - CO/CI 5.53/3.64, PVR 16.2 Wood units
- Most recent office visit: July 2024
  - FC 1, 6MWD 617 m, BNP 48
- Low risk by both 4-strata and REVEAL Lite 2

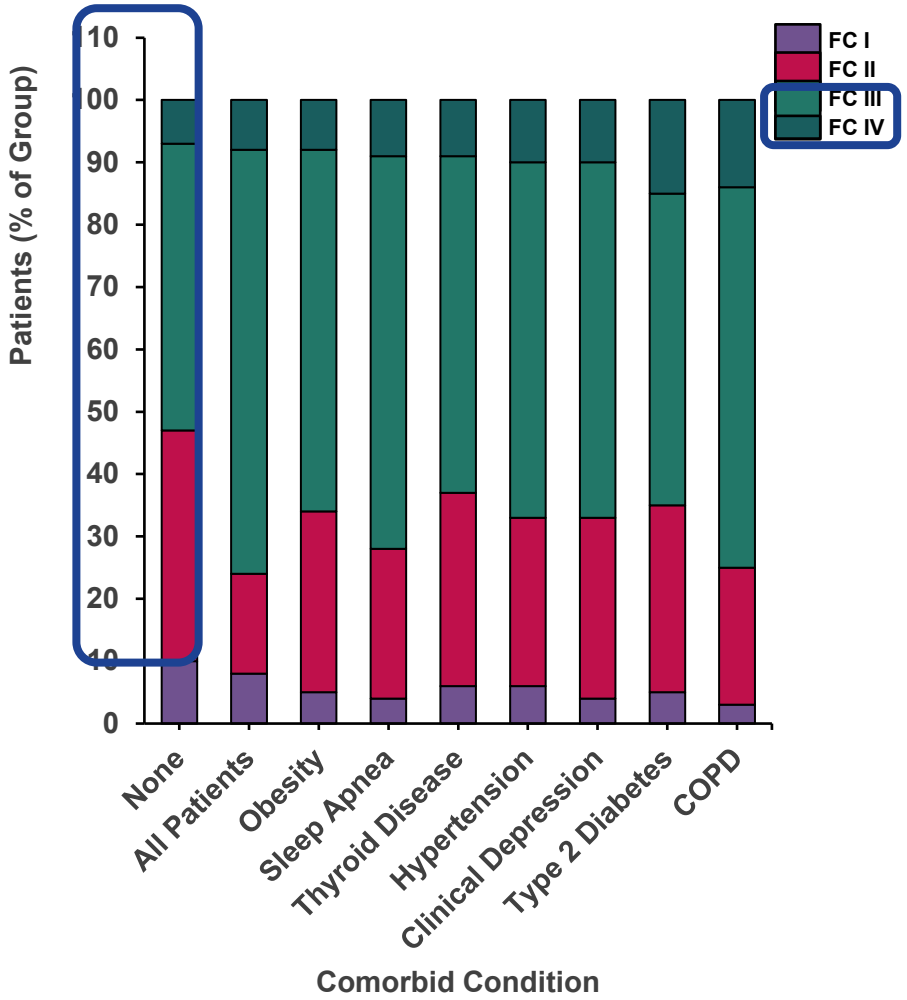
Patient LB-Apical 4 Chamber

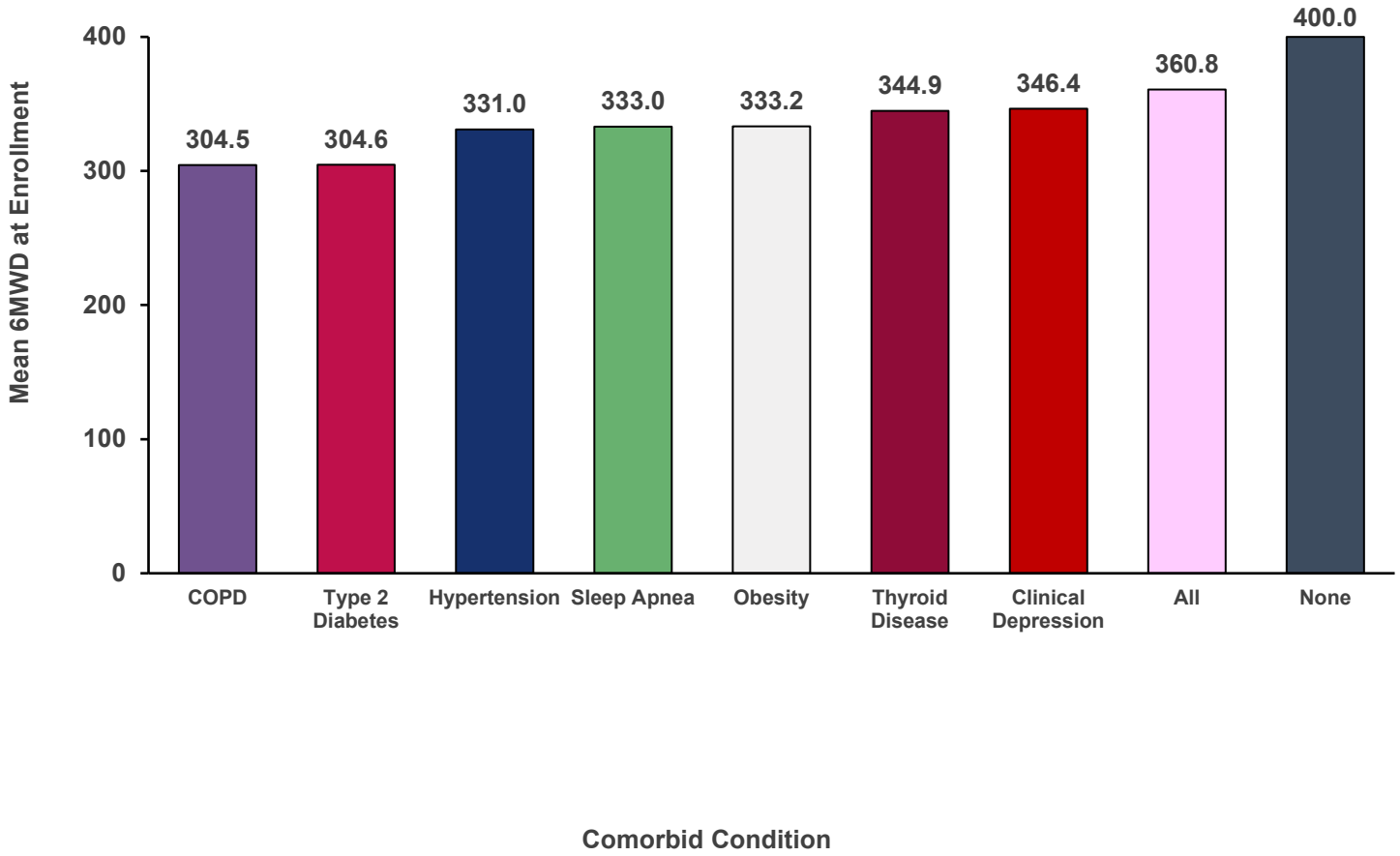


Patient LB-Parasternal Short Axis



REVEAL Registry Analysis: Prognostic Factors



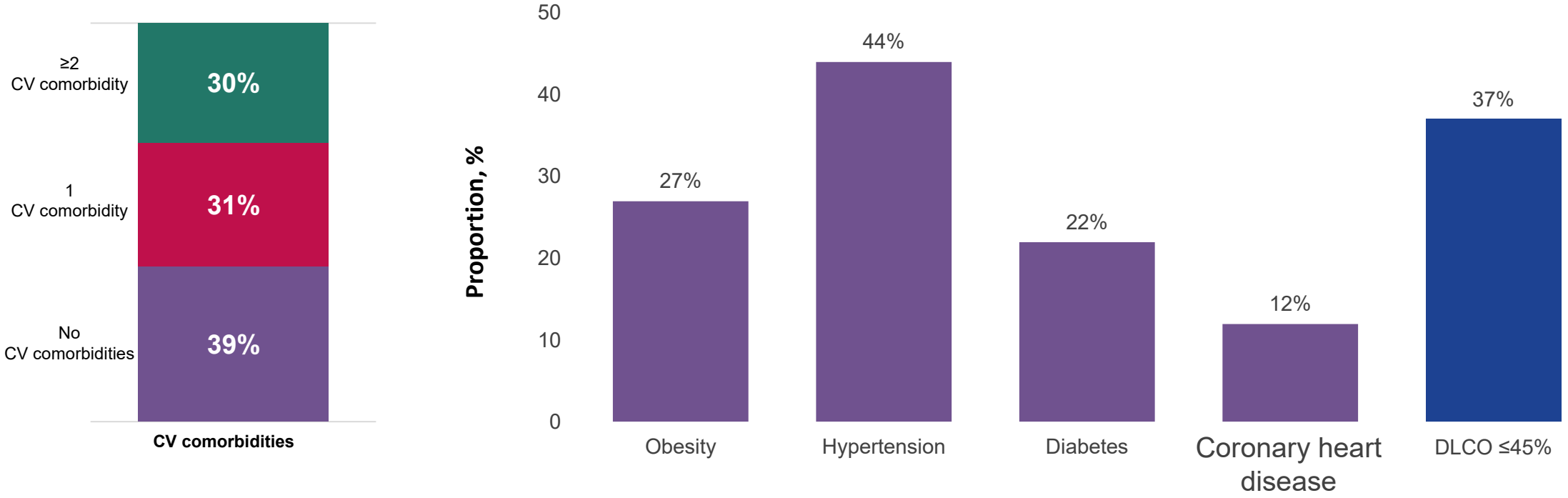


Subjects with Group 1 PAH with any comorbidity had worse FC and 6MWD

Poms AD, et al. *Chest*. 2013;144(1):169-176.

Prevalence of Cardiopulmonary Comorbid Conditions in PH: French PH Registry

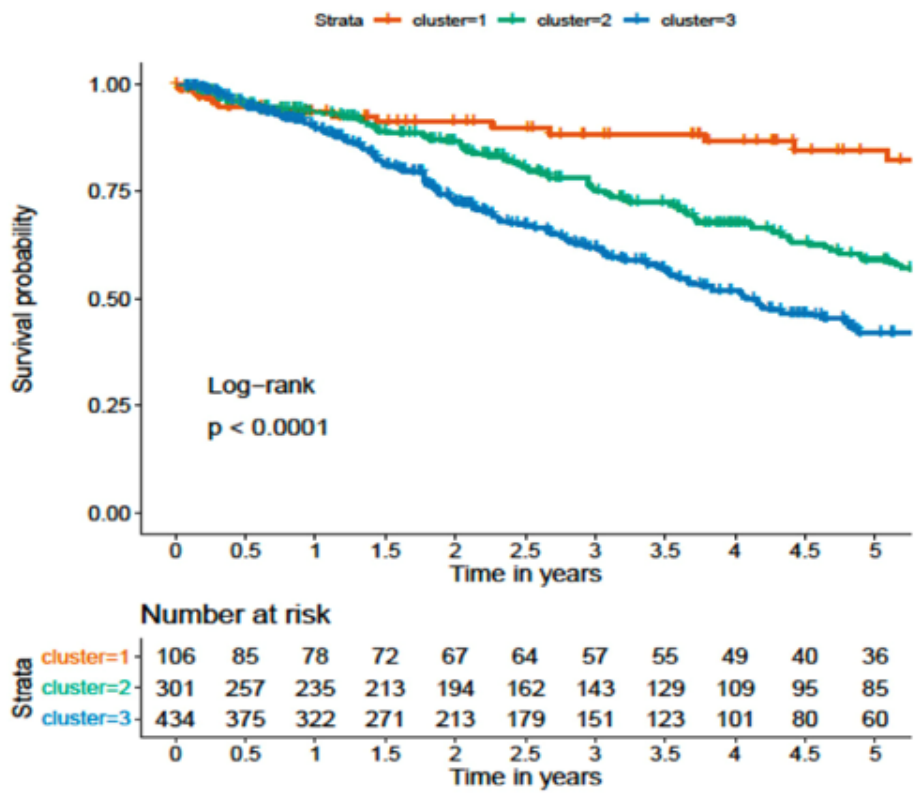
- 60% of patients with PAH have at least 1…



Slide courtesy of Olivier Sitbon, MD, French PH Registry data on file.

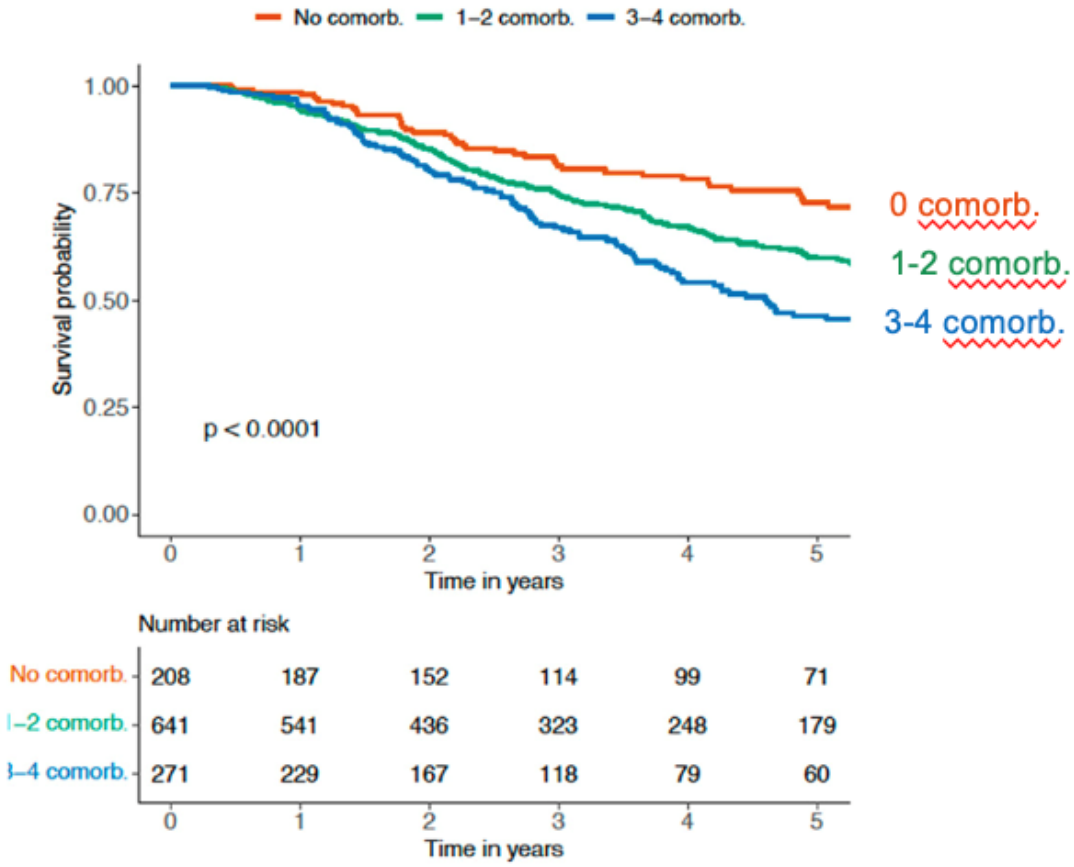
Do Cardiopulmonary Comorbidities in PH Affect Outcomes?

iPAH phenotypes



Hoeper MM, et al. *J Heart Lung Transplant.* 2020:39(12):1435-1444.

CV comorbidities

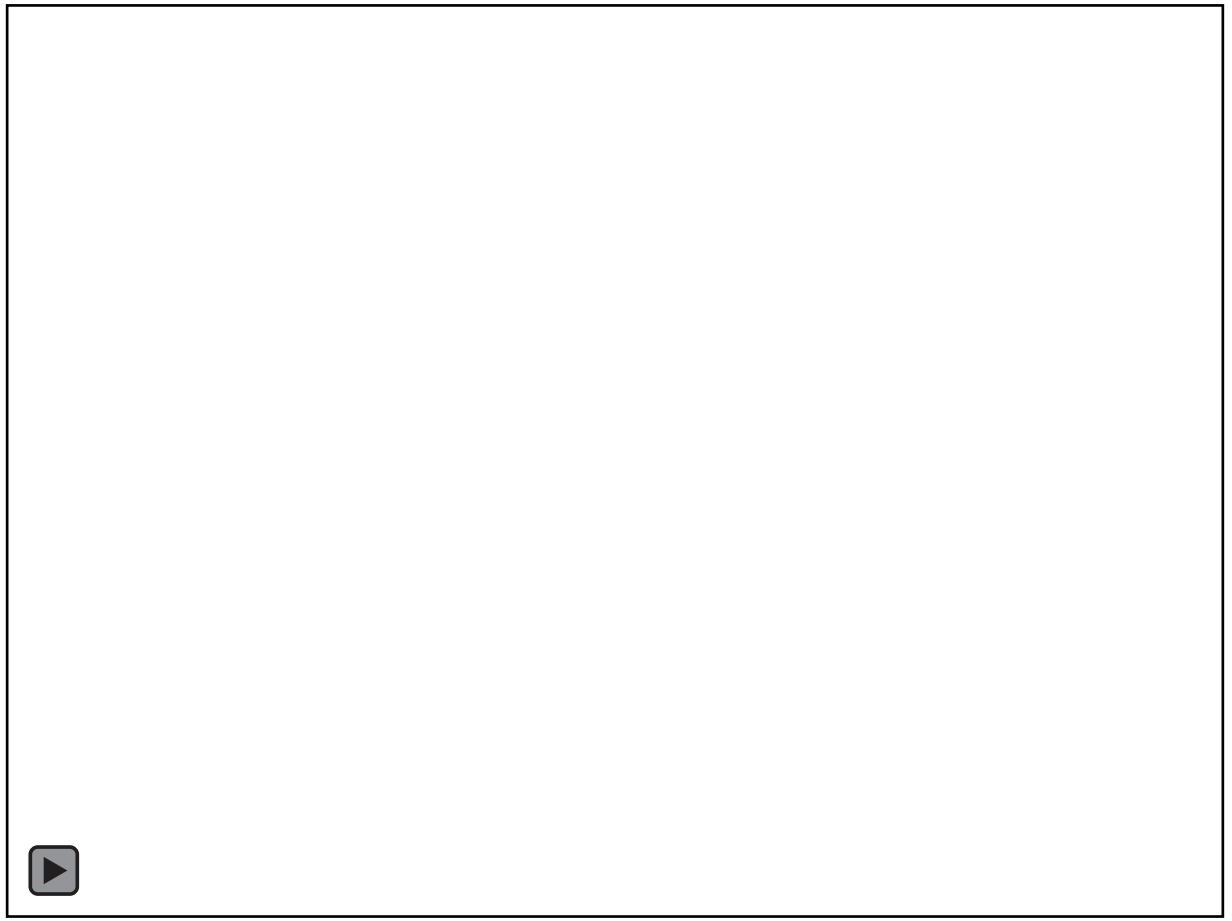


Rosenkranz S, et al. *J Heart Lung Transplant*. 2023;42(1):102-114.

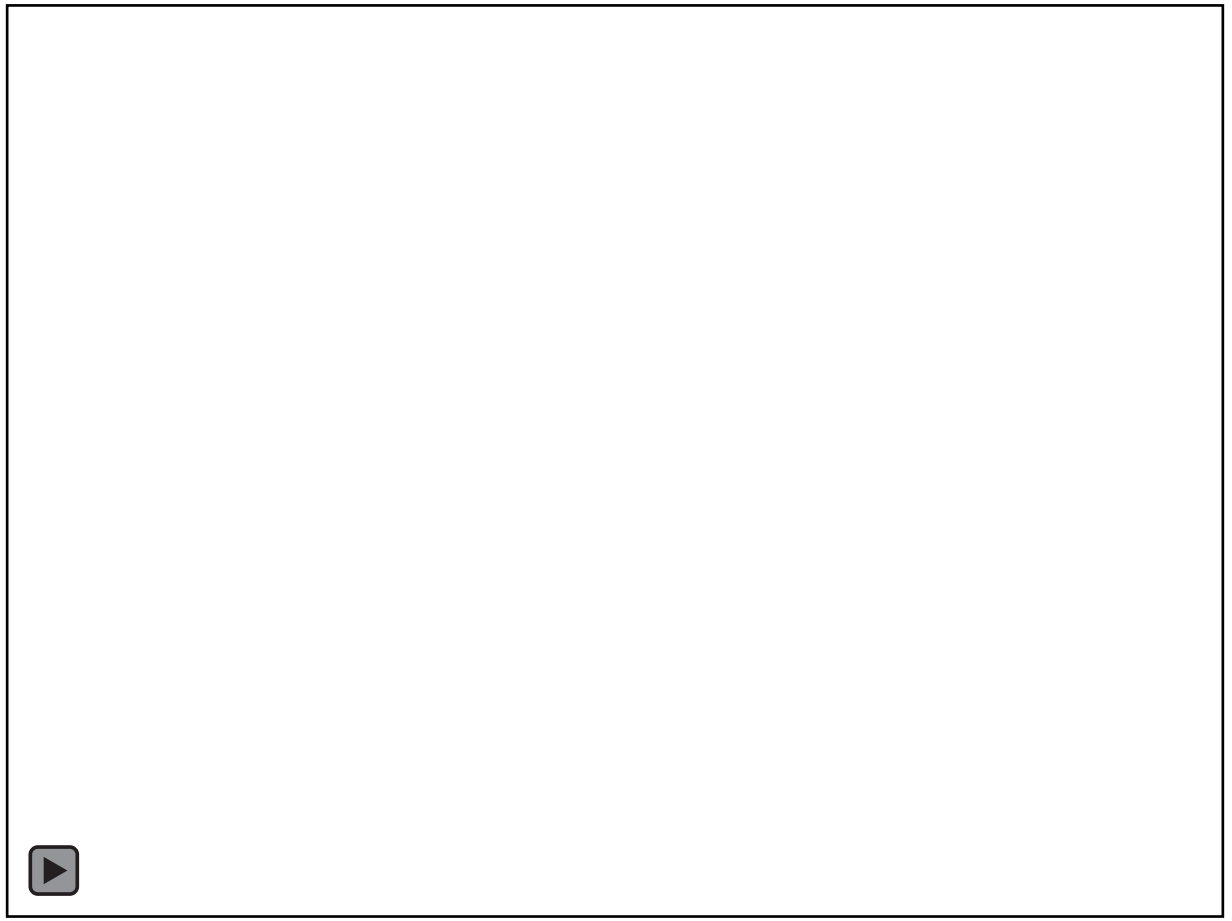
Patient JD

- 75 yo woman with PAH r/t scleroderma dx 2012
  - mPAP 33, PCWP 11, CO/CI 5.95, 3.18
  - PVR 3.2 WU, treated with PDE5i monotherapy
- Repeat RHC 7/19, PVR 2.8
- Last office visit: 8/24
  - FC3, HW 244, BNP 128
- Risk status
  - Intermediate high by 4 strata, intermediate by REVEAL Lite 2

Patient JD



Patient JD



PAH Therapy Decisions