HIGH CARDIAC OUTPUT HEART FAILURE

Arezoo Mohamadifar

Cardiologist

Fellowship of heart failure and transplantation

Massih Daneshvari Hospital

CASE 1

- 43-year-old Female, DOE FC IV , systemic hypertension, sleep apnea, and ESRD due to glomerulonephritis,
- Hemodialysis, left brachial AV fistula that had been placed 10 years earlier.
- Physical examination : JVP of 15 cm water without peripheral edema or rales.
- The ECG revealed normal sinus rhythm at 75 beats per minute and LVH.

- ECHO: Normal LV size and systolic Function , LVEF: 50-55 %

  Severe RV enlargement (5.6 cm), normal systolic function

  Moderate LVH,

  Moderate LA enlargemet , E/E' : 20 m/s

  RRVOT AccT : 85 ms

  TRV: 3.8 m/s

Table 8A **Echocardiographic probability of pulmonary hypertension in symptomatic patients with a suspicion of pulmonary hypertension**

Peak tricuspid regurgitation velocity (m/s)	Presence of other echo 'PH signs'[a]	Echocardiographic probability of pulmonary hypertension
≤2.8 or not measurable	No	Low
≤2.8 or not measurable	Yes	Intermediate
2.9–3.4	No	
2.9–3.4	Yes	High
>3.4	Not required	

RIGHT HEART CATHETERIZATION

Variable	
CO(L/min) Fick method	11
CI(L/min/m2)	6.1
PCWP(mmHg)	18
PAP(mmHg)mean	70/30(43)
RA pressure (mmHg)	17
RV pressure(mmHg)	70/0-20
PVR (wood)	2.2
SVR(wood)	8.1
Systemic Arterial O2 saturation	97%
Mixed venous O2 saturation	82%

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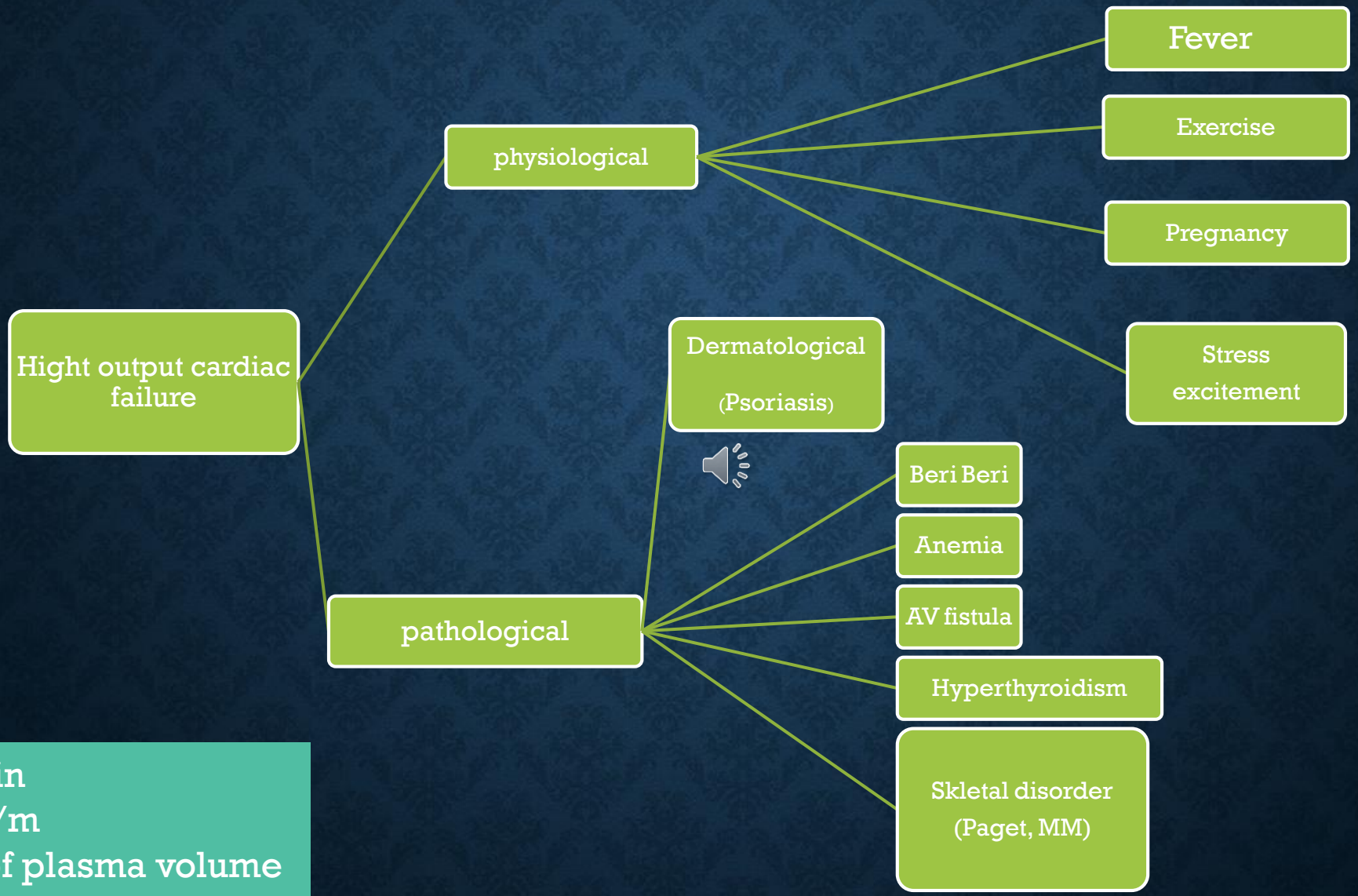
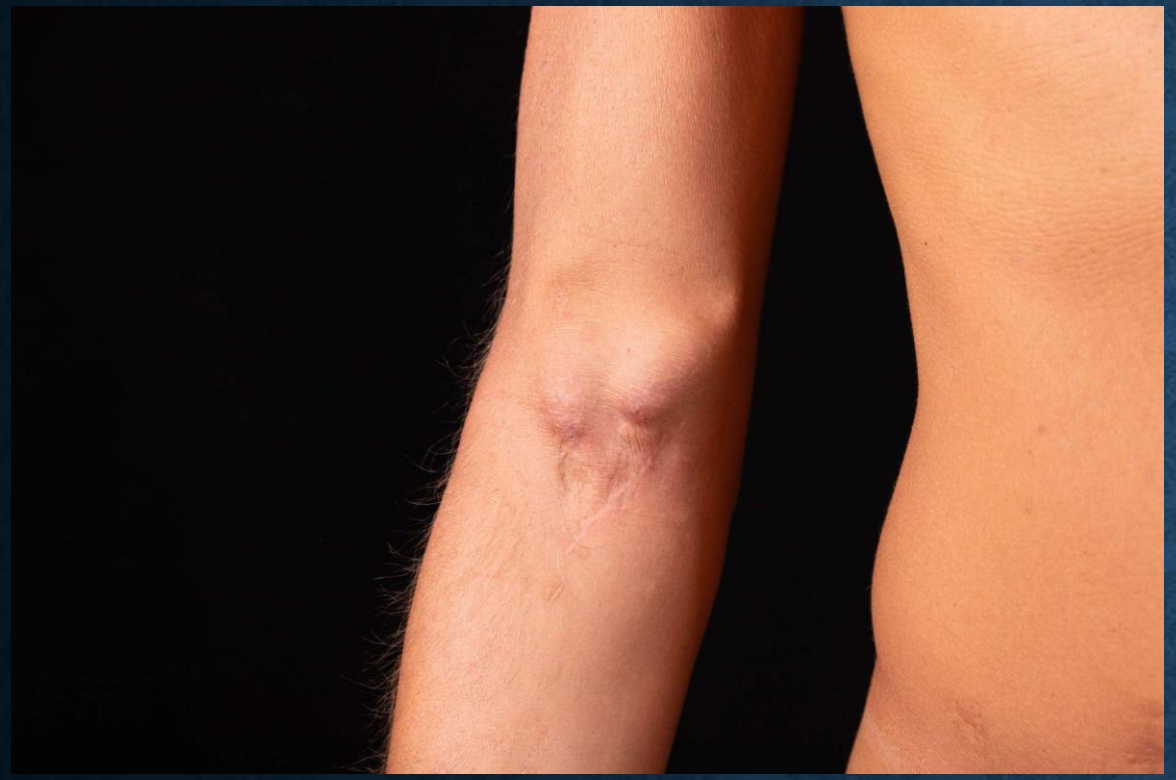
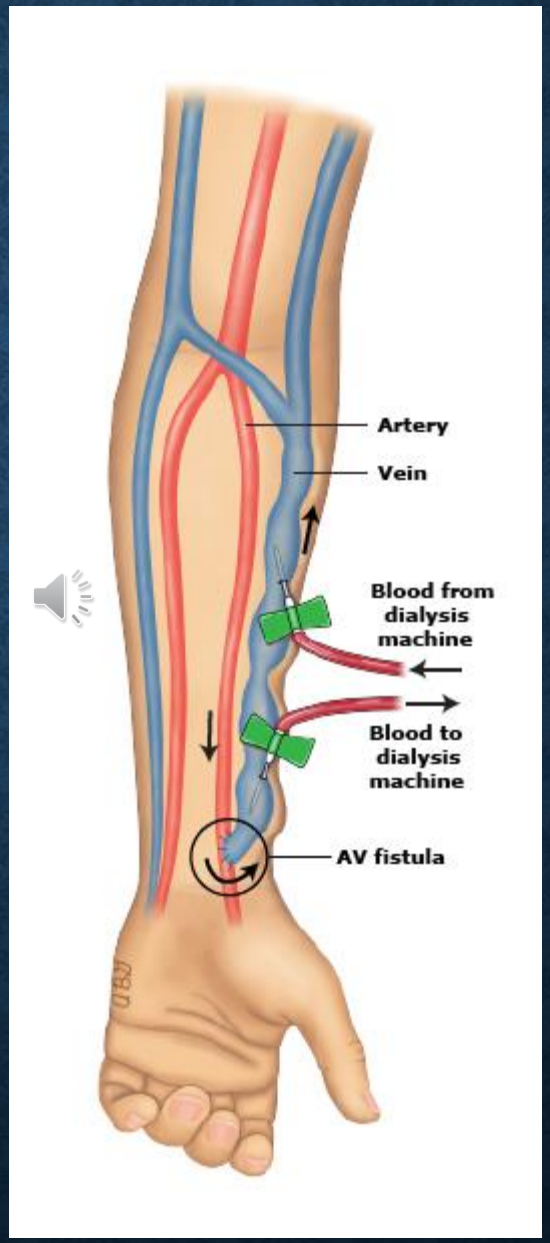
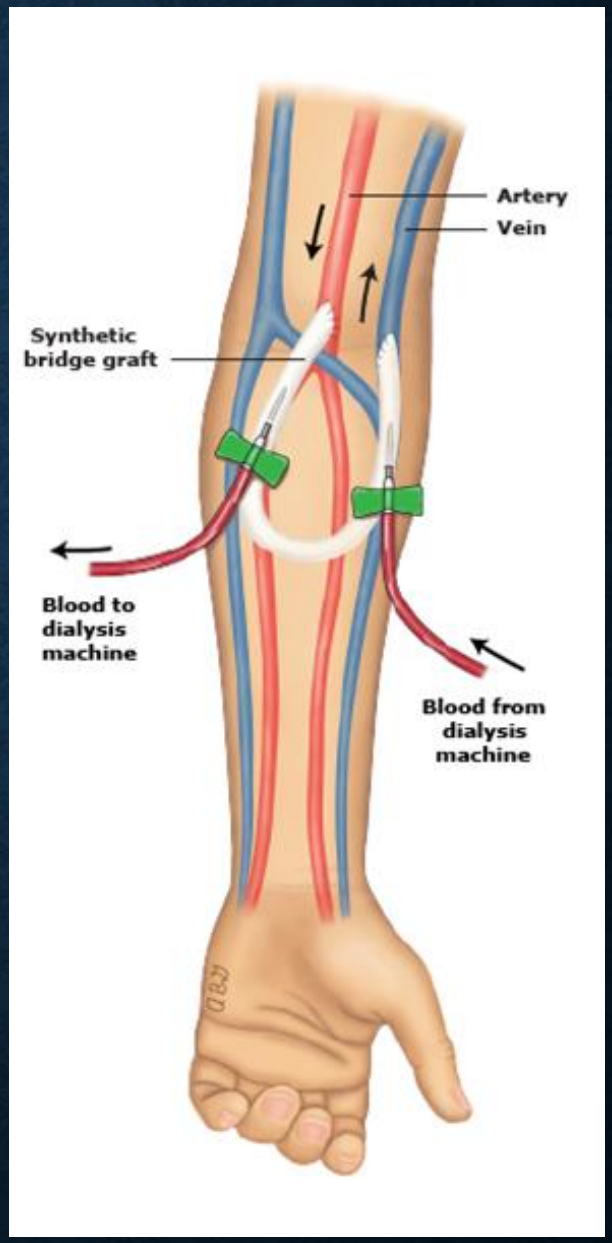


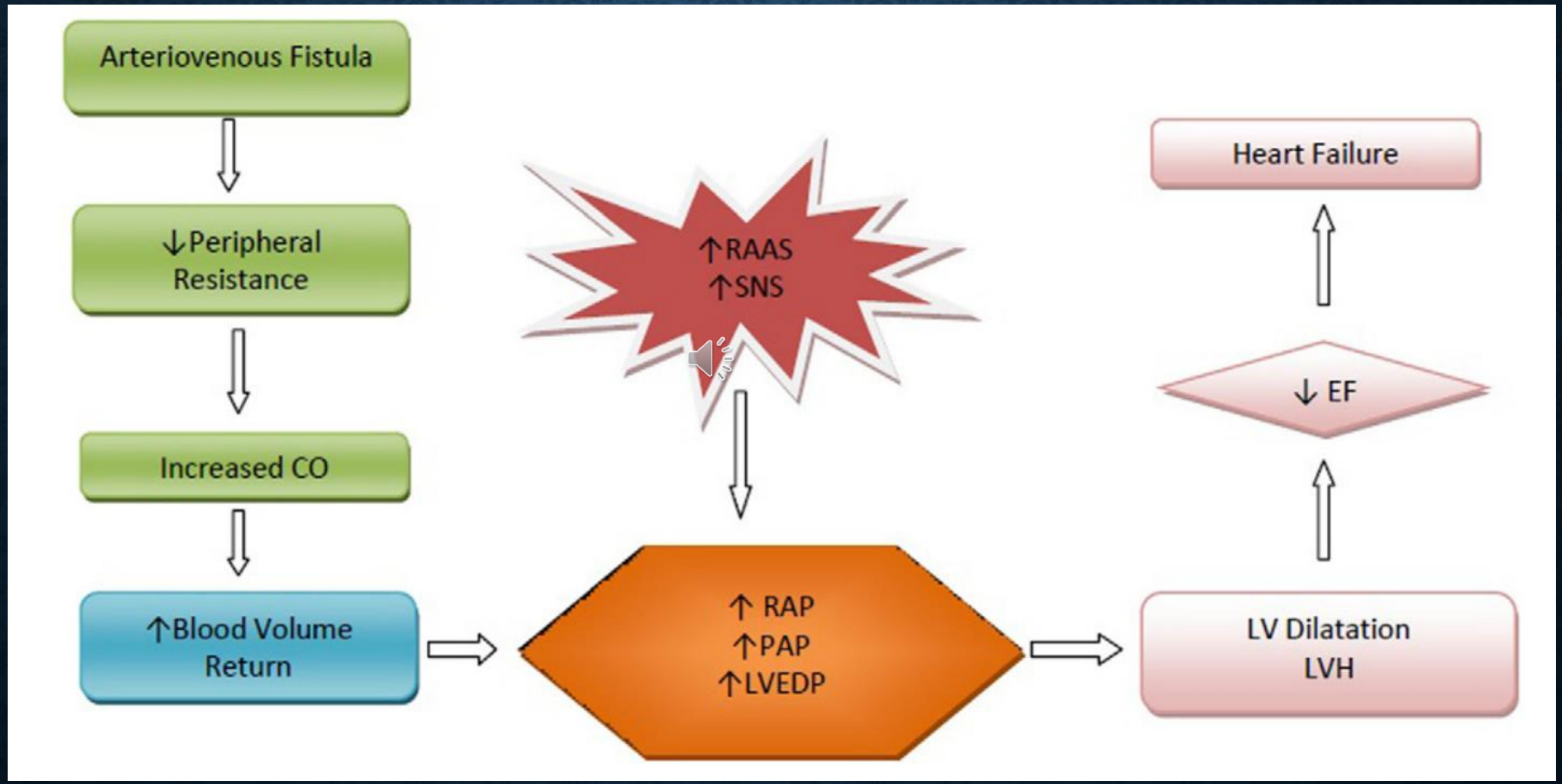
- CO > 8 L/min
- CI>3.9/min/m
- expansion of plasma volume
- elevated cardiac filling pressures
- elevated (BNP)



Arteriovenous fistula (AVF)
Arteriovenous graft (AVG)






Arteriovenous Fistula
↓Peripheral Resistance
Increased CO
↑Blood Volume Return
↑RAAS
↑SNS
↑ RAP
↑PAP
↑LVEDP
LV Dilatation
LVH
↓ EF
Heart Failure

Low SVR

HOCF

High CO

Reduced A_V oxygen content difference

RISK FACTORS

- Vascular access blood flow (Qa) of 2.0 L/min or greater
- The ratio of vascular access flow to CO (Qa/CO) : Qa/CO ratio greater than 0.30
- anastomosis size of more than 4–6 mm, proximal AVF , Upper-arm AV access
- Male sex
- Previous vascular access surgery
- History of underlying coronary disease

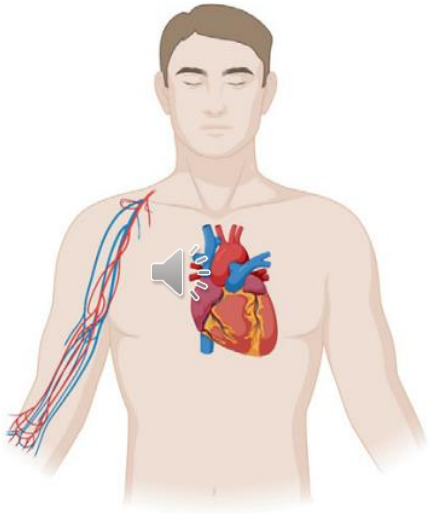
- ***<u>End stage renal disease itself is a risk factor for the development of HOCF</u>***

1. Fluid overload due to salt and water retention by the kidneys
2. Hypertension, arterial sclerosis
3. Chronic anemia

De novo HF

Decompensated HF

RV dysfunction



Decompensated aortic stenosis

Coronary ischemia--> CAD

LV dysfunction

Intereference with CABG

Pulmonary Hypertension

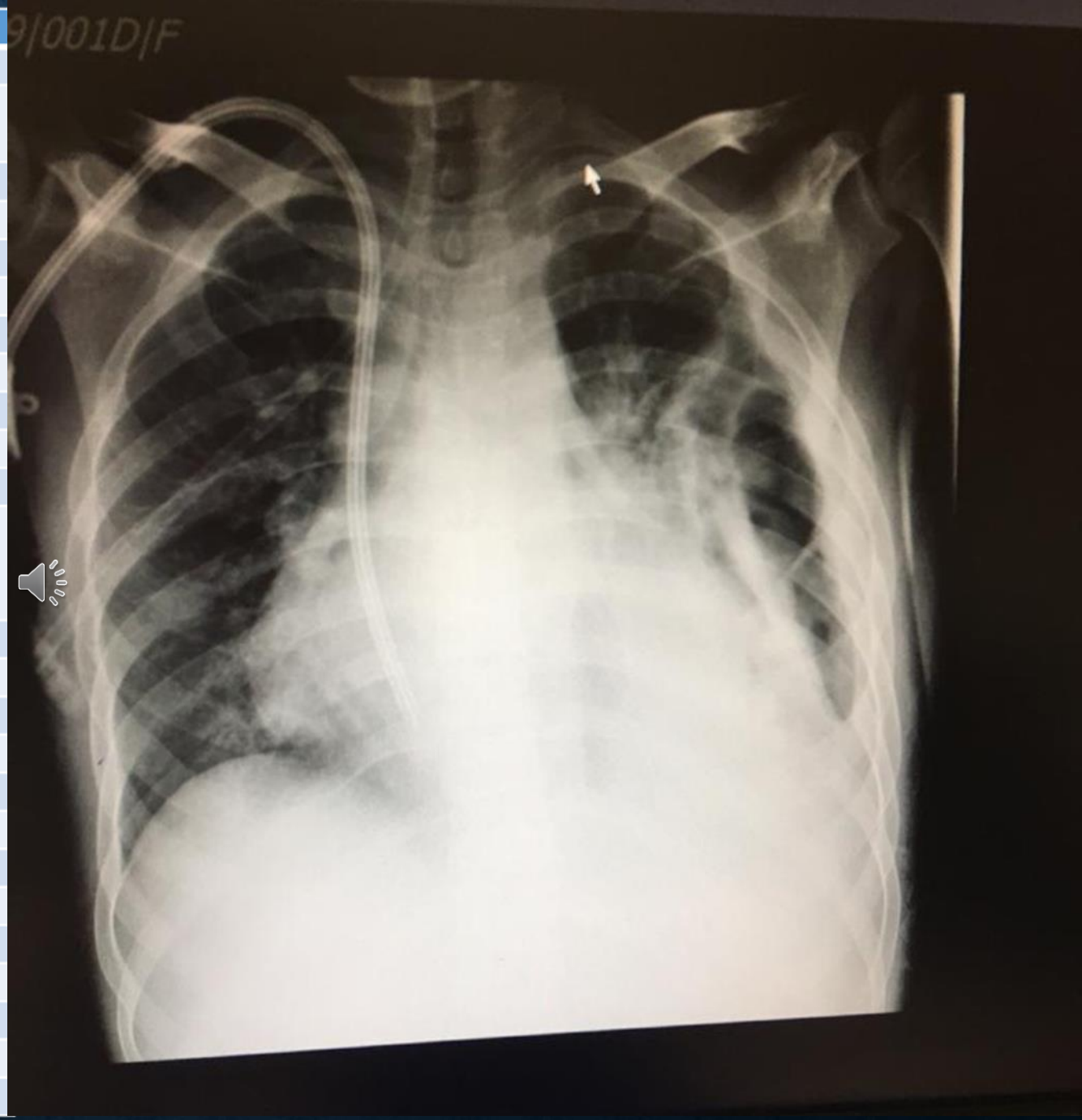
- Symptoms : dyspnea at rest or with exertion, orthopnea, and fatigue
- On examination: tachycardia, edema, jugular venous distention, a wide pulse-pressure, midsystolic murmur, caused by increased ventricular filling, and warm extremities as a result of low systemic vascular resistance.

ASSESSMENT

- CXR: cardiomegaly, pulmonary edema, pleural effusion.
- Transthoracic echocardiogram : Right and left ventricular function and estimate pulmonary artery pressure.LV dilation and pulmonary hypertension
- Right heart catheterization : high cardiac output, pulmonary hypertension with normal pulmonary vascular resistance, and low-normal systemic vascular resistance.
- Access blood flow routinely should be measured and documented during monthly vascular access surveillance

- 36-year-old female with SOB (FC IV) and uncontrolled HTN
- PMH: ESRD on HD 3 times / week for 4 years , HTN, HFrEF, PTE 2 years ago pleural effusion , empyema and chest tube insertion 3 years ago.
- DH: losartan 50 mg BID,Amlodipin 5 mg BID, prazosin 5 mg BID, warfarin, Aldacton 25 mg once daily , Carvedilol 6.25 mg BID.Nephrovit
- Drug abuse: pethedin
- PE:BP of 210/110, PR: 110 bpm, O2 sat 89 % in air room , JVD

Haemoglobin (g/dl)	9.5	14.0-17.5
Haematocrit (%)	30.7	41.5-50.4
White-cell count (per mm^3)	4.55	4,000-11,000
Platelet count (permm^3)	135000	150,000-450,000
Sodium (mEq/lit)	140	135-145
Potassium (mEq/lit)	4.6	3.5-5.5
Urea nitrogen (mg/dl)	114	10-50
Creatinine (mg/dl)	5.5	0.9-1.3
Glucose(mg/dl)	94	70-100
Troponin I(ng/ml)	<0.07	<0.02
Calcium	8.6	8.6-10.3
Albumin (g/dl)	7.3	3.8-5.1
N-terminal pro-B-type natriuretic peptide (pg/ml)	7870	<120
ESR (mm/h)	3	
CRP(mg/l)	8	
Lactate de hydrogenase	240	225-500
PH	7.27	
PCO2	49	
HCO3	23	
SI	80	
TIBC	227	
AST	23	
ALT	16	
Bill T	1.5	
Bill D	0.5	



TTE

- Severe LV enlargement , severe systolic dysfunction , LVEF :10-15%
- Significant diastolic dysfunction
- Biatrial enlargement
- Severe RV enlargement with severe systolic dysfunction
- Severe MR
- Severe TR, TRV : 3.9 m/s
- IVD dilated (2.4cm) with < 50 % collapse with inspiration

PLAN

- Optimizing medical treatment and HD 5 times /week
- Valsartan 160mg BID, Amlodipin 5 mg BID, Lasix 40 IV TDS , Carvedilol 6.25 mg BID, Hydralazin 50 mg TDS , clonidine 0.2 mg BID, prazosin 5 mg TDS

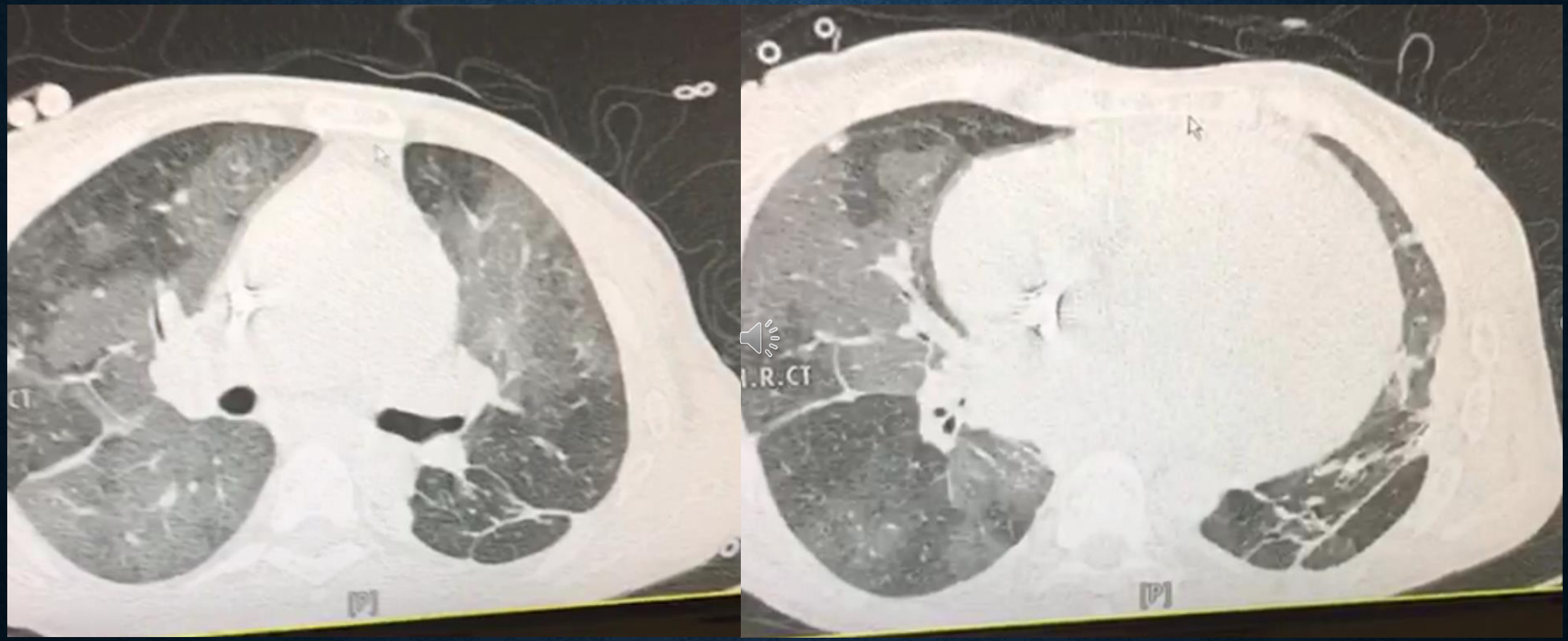
- Patient was symptomatic DOE FC III

Variable	
CO(L/min) Fick method	5.9
CI(L/min/m2)	4.8
PCWP(mmHg)	15
PAP(mmHg)mean	55/25(35)
RA pressure (mmHg)	10
RV pressure(mmHg)	55/5-15
PVR (wood)	3.3
SVR(wood)	17.7
Systemic Arterial O2 saturation	98%
Mixed venous O2 saturation	78%
TPG(mmHg)	20
DPG(mmHg)	10

- V/Q lung scan : multiple large segmental wedge shaped perfusion defect in both lungs

  Highly suggestive for CTEPH

- Rheumatologic tests : unremarkable


I.R.CT
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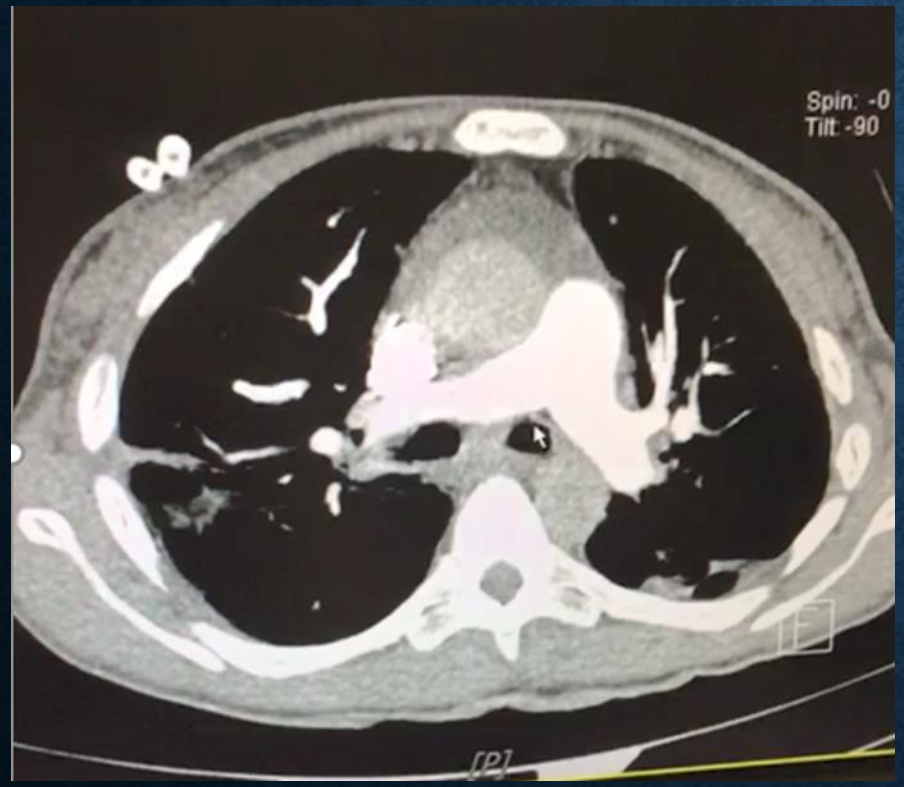
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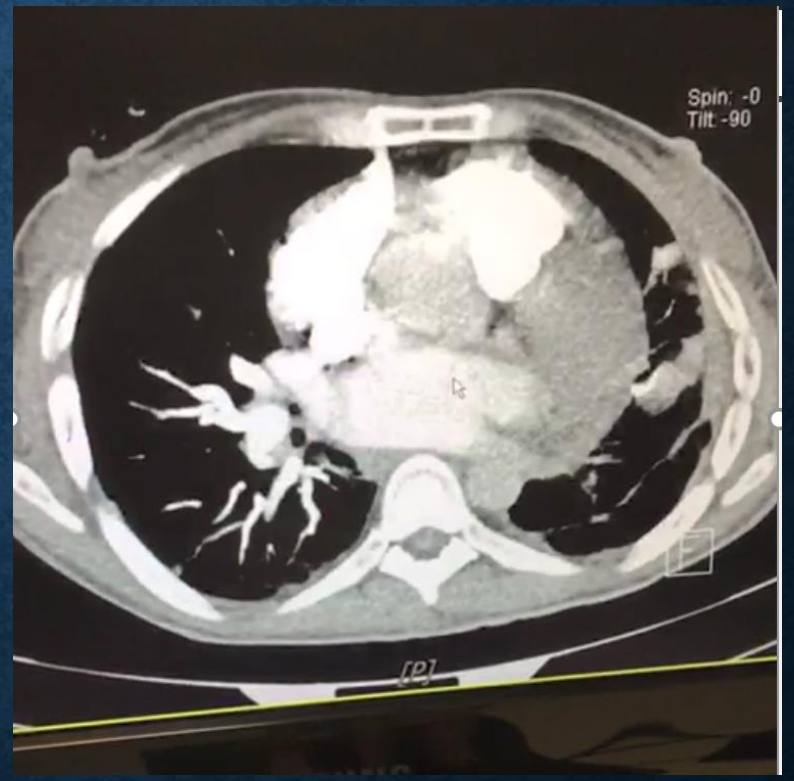
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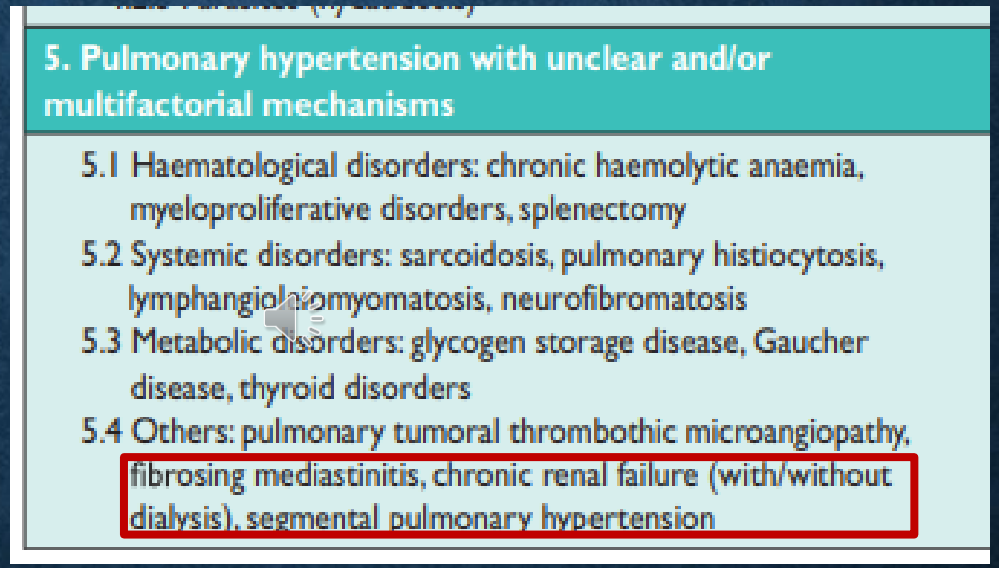
Table 4 Comprehensive clinical classification of pulmonary hypertension (updated from Simonneau *et al.*[5])

1. Pulmonary arterial hypertension
1.1 Idiopathic
1.2 Heritable
1.2.1 BMPR2 mutation
1.2.2 Other mutations
1.3 Drugs and toxins induced
1.4 Associated with:
1.4.1 Connective tissue disease
1.4.2 Human immunodeficiency virus (HIV) infection
1.4.3 Portal hypertension
1.4.4 Congenital heart disease (Table 6)
1.4.5 Schistosomiasis
1'. Pulmonary veno-occlusive disease and/or pulmonary capillary haemangiomatosis
1'.1 Idiopathic
1'.2 Heritable
1'.2.1 EIF2AK4 mutation
1'.2.2 Other mutations
1'.3 Drugs, toxins and radiation induced
1'.4 Associated with:
1'.4.1 Connective tissue disease
1'.4.2 HIV infection
1''. Persistent pulmonary hypertension of the newborn
2. Pulmonary hypertension due to left heart disease
2.1 Left ventricular systolic dysfunction
2.2 Left ventricular diastolic dysfunction
2.3 Valvular disease
2.4 Congenital / acquired left heart inflow/outflow tract obstruction and congenital cardiomyopathies
2.5 Congenital /acquired pulmonary veins stenosis
3. Pulmonary hypertension due to lung diseases and/or hypoxia
3.1 Chronic obstructive pulmonary disease
3.2 Interstitial lung disease
3.3 Other pulmonary diseases with mixed restrictive and obstructive pattern
3.4 Sleep-disordered breathing
3.5 Alveolar hypoventilation disorders
3.6 Chronic exposure to high altitude
3.7 Developmental lung diseases (Web Table III)
4. Chronic thromboembolic pulmonary hypertension and other pulmonary artery obstructions
4.1 Chronic thromboembolic pulmonary hypertension
4.2 Other pulmonary artery obstructions
4.2.1 Angiosarcoma
4.2.2 Other intravascular tumors
4.2.3 Arteritis
4.2.4 Congenital pulmonary arteries stenoses
4.2.5 Parasites (hydatidosis)
5. Pulmonary hypertension with unclear and/or multifactorial mechanisms
5.1 Haematological disorders: chronic haemolytic anaemia, myeloproliferative disorders, splenectomy
5.2 Systemic disorders: sarcoidosis, pulmonary histiocytosis, lymphangioleiomyomatosis, neurofibromatosis
5.3 Metabolic disorders: glycogen storage disease, Gaucher disease, thyroid disorders
5.4 Others: pulmonary tumoral thrombothic microangiopathy, fibrosing mediastinitis, chronic renal failure (with/without dialysis), segmental pulmonary hypertension



SEVERITY OF HEART FAILURE SHOULD BE CONSIDERED IN VASCULAR ACCESS SELECTION

- Consider the patient's underlying cardiac status
- Severity of HF (FC IV)
- Catheter dialysis could be used for patients with an EF < 30% or New York Heart Association Functional Classification III-IV
- Upper-arm AV access


Development of HOCF
Still require RRT?
Yes
No i.e. had renal transplant
Start medical treatment and consider banding
Consider AVF ligation
HFpEF
HFrEF
Treat with low dose diuretics
1. ACE-I and Beta blocker
2. Add MRA
3. Consider ivabradine
4. Consider valsartan
If unsuccessful, consider surgery:
1. Consider ICD, CRT, CRT-D or CRT-P

THANKS FOR YOUR ATTENTION