

Khảo sát và điều trị Suy tim phải (Evaluation and Management of Right-sided Heart Failure)

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Bệnh viện Tim Tâm Đức

Đại học Y khoa Phạm Ngọc Thạch

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Viện Tim Tp. HCM

Một số điểm chính của Suy tim phải

❖ Nguyên nhân:

- BCT nguyên phát ở TP
- TMCB và nhồi máu TP
- Tăng tải thể tích do BTBS hay bệnh van tim
- Tăng tải áp lực do hẹp ĐMP hay tăng áp lực phổi do nhiều nguyên nhân

❖ Suy tim phải cấp:

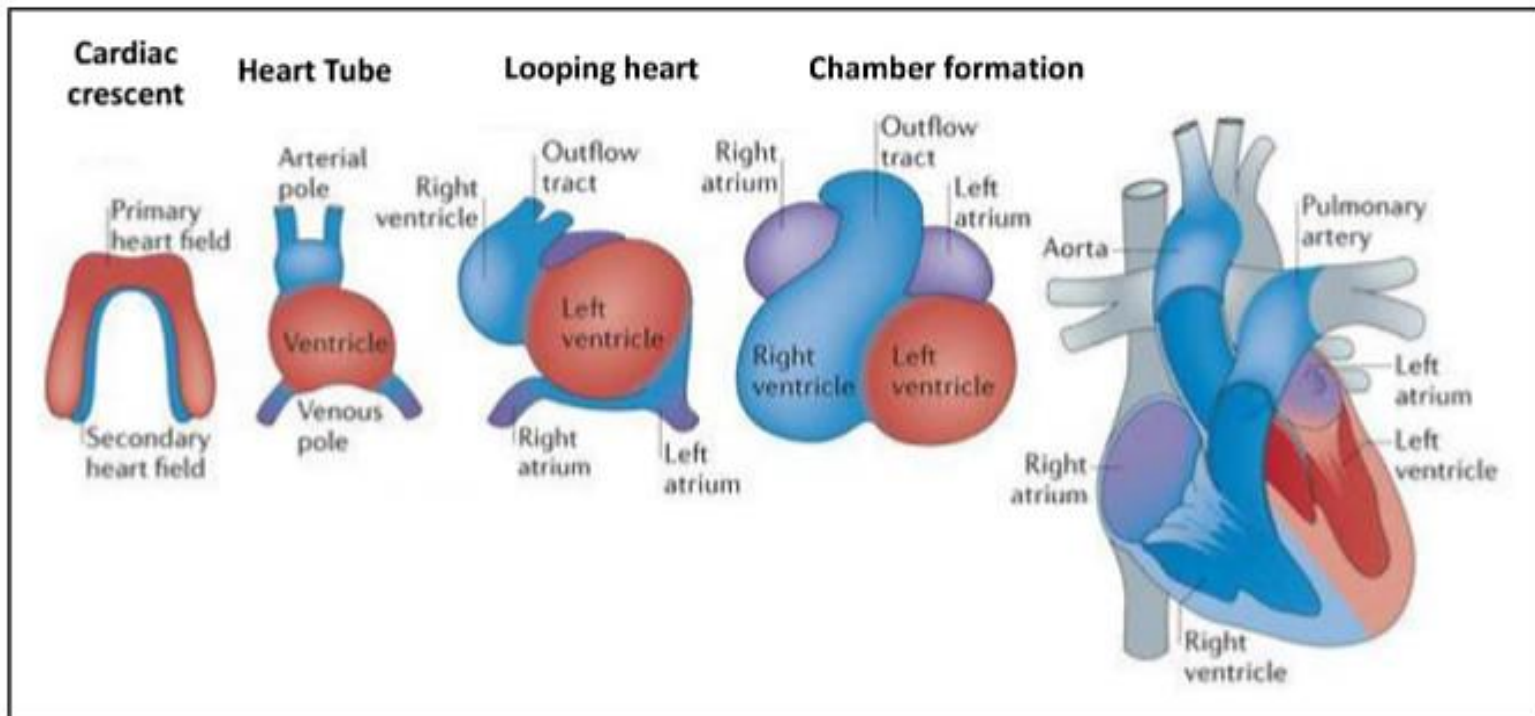
- Huyết động không ổn
- Nguyên nhân chính của tử vong do TTP ồ ạt
- Nhồi máu cơ tim TP
- Sốc sau xẻ màng tim/BN phẫu thuật tim

Một số điểm chính của Suy tim phải (tt)

❖ Suy tim phải mạn:

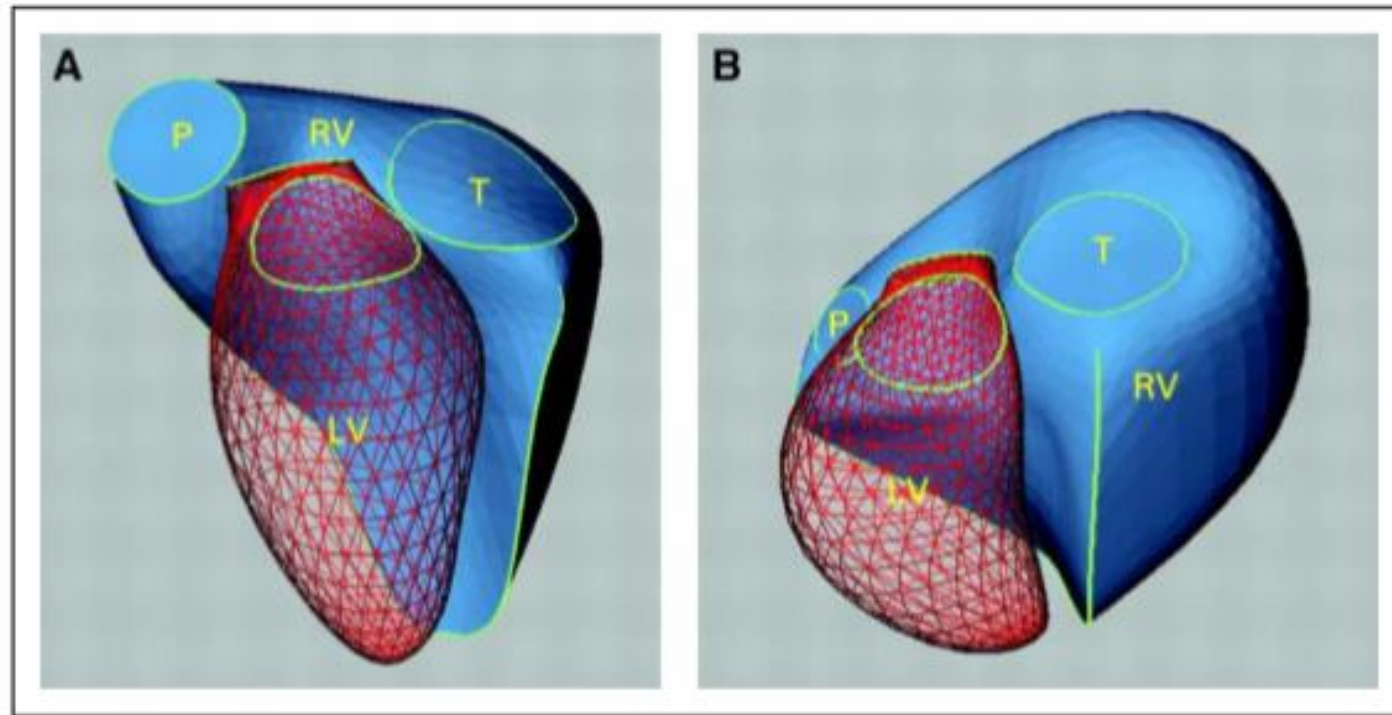
- Giảm khả năng gắng sức
- Giảm dung nạp vận động
- Giảm cung lượng tim
- Tổn thương tiến triển cơ quan bia
- Suy kiệt do hấp thu kém
- Tăng viêm hệ thống

Cardiac embryogenesis



- Primary heart field (from Mesoderm) → Heart tube
- Heart tube:
 - Atria
 - Ventricles
- Secondary heart field → arterial and venous poles

Right ventricular (RV) geometry



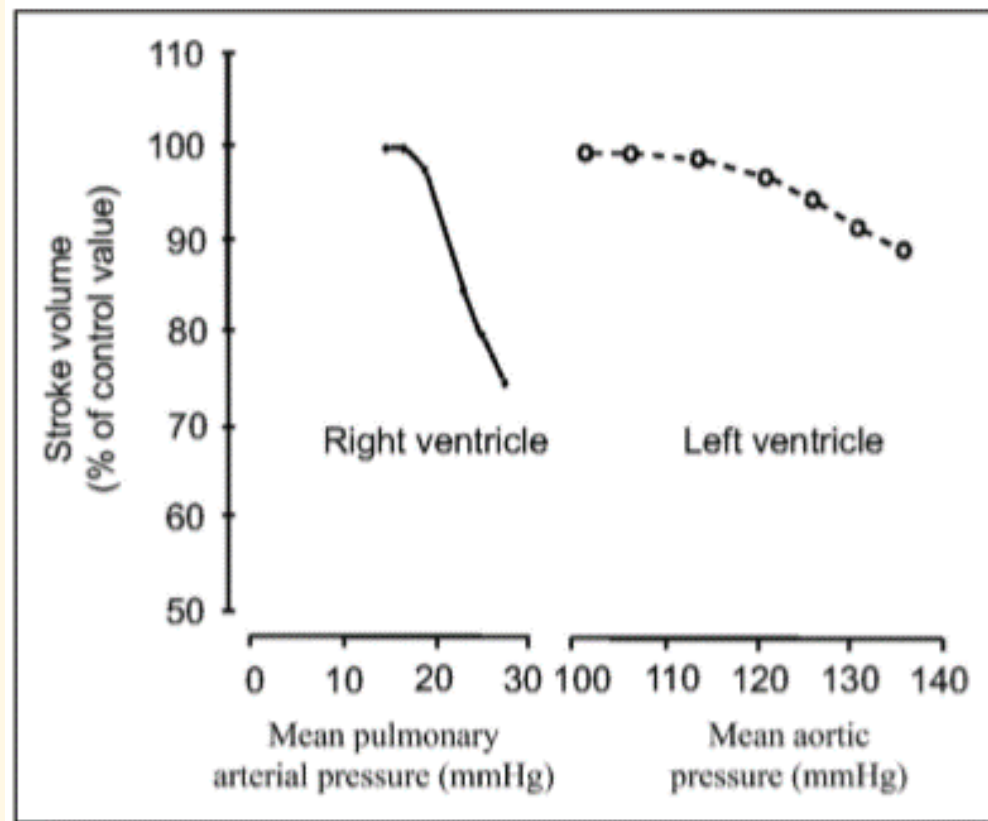
Normal subject

**Chronic volume or pressure
overload**

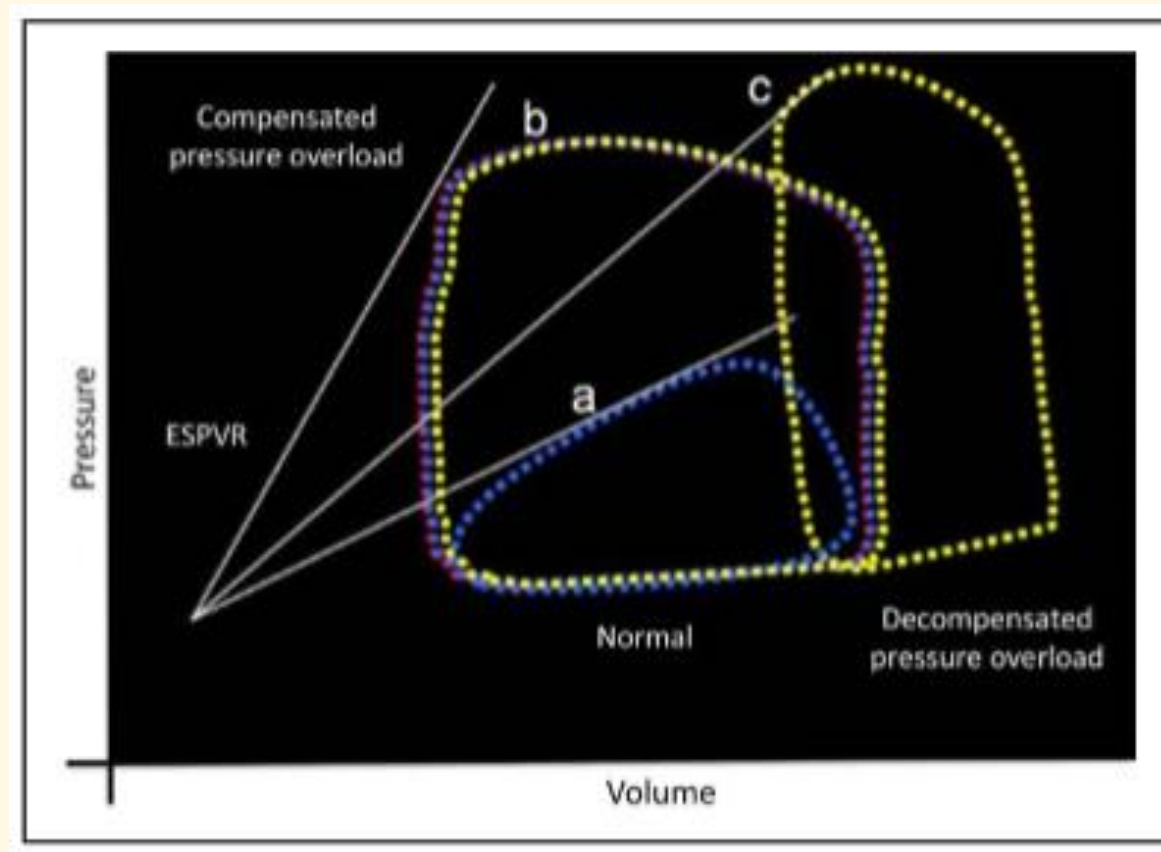
P: Pulmonary valve

T: Tricuspid valve

Relationship of RV and LV stroke volumes to increases in afterload



RV pressure-volume loops

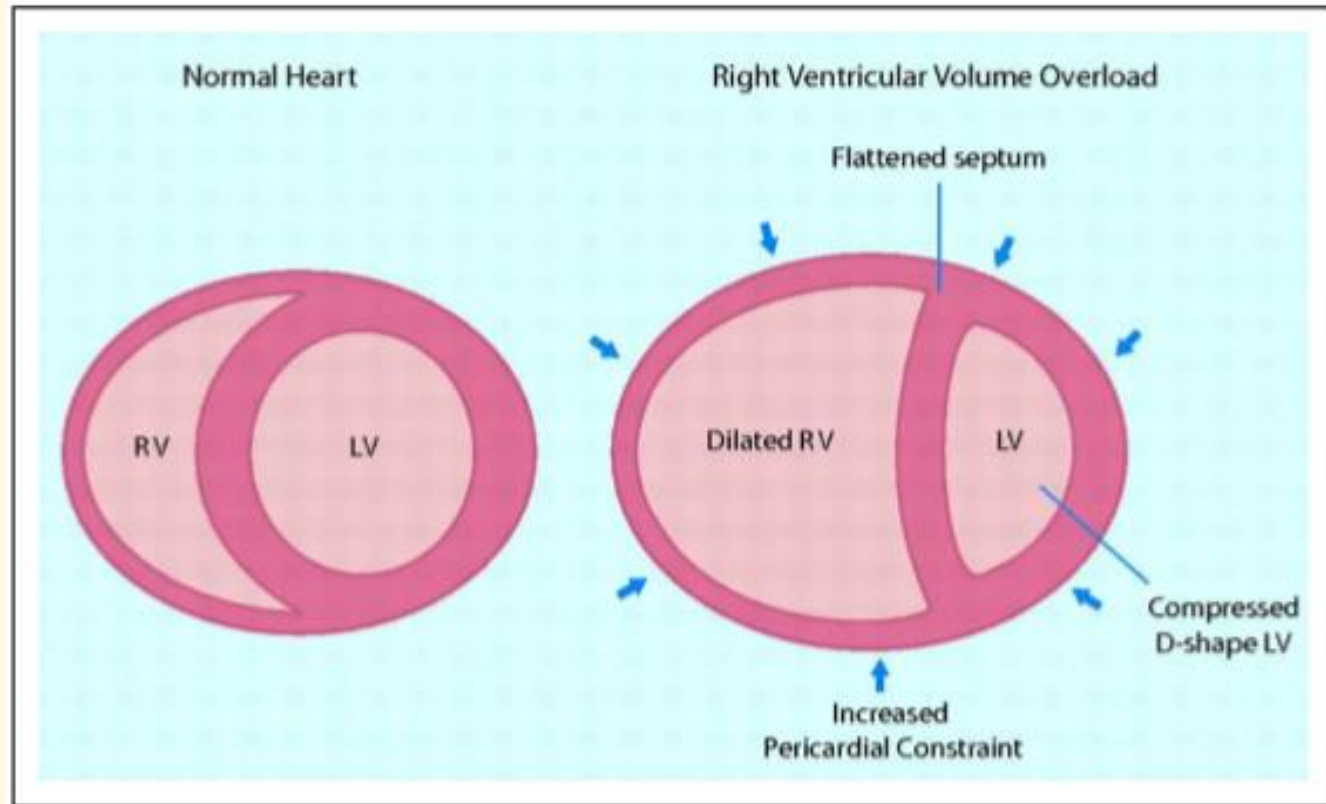


ESPVR : End-systolic pressure volume relationship

Ees: end-systolic elastance

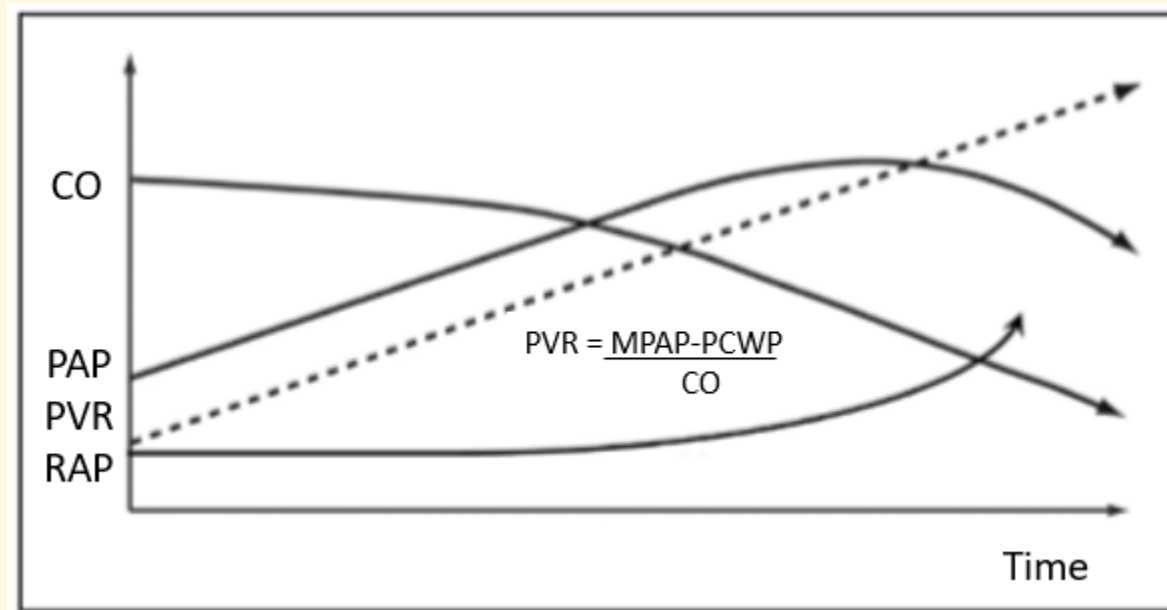
Loop C: decompensated hypertensive RV

Ventricular interdependence in right-sided heart failure



RV is constrained by the pericardium (arrows)

Hemodynamics in progressive pulmonary vascular disease



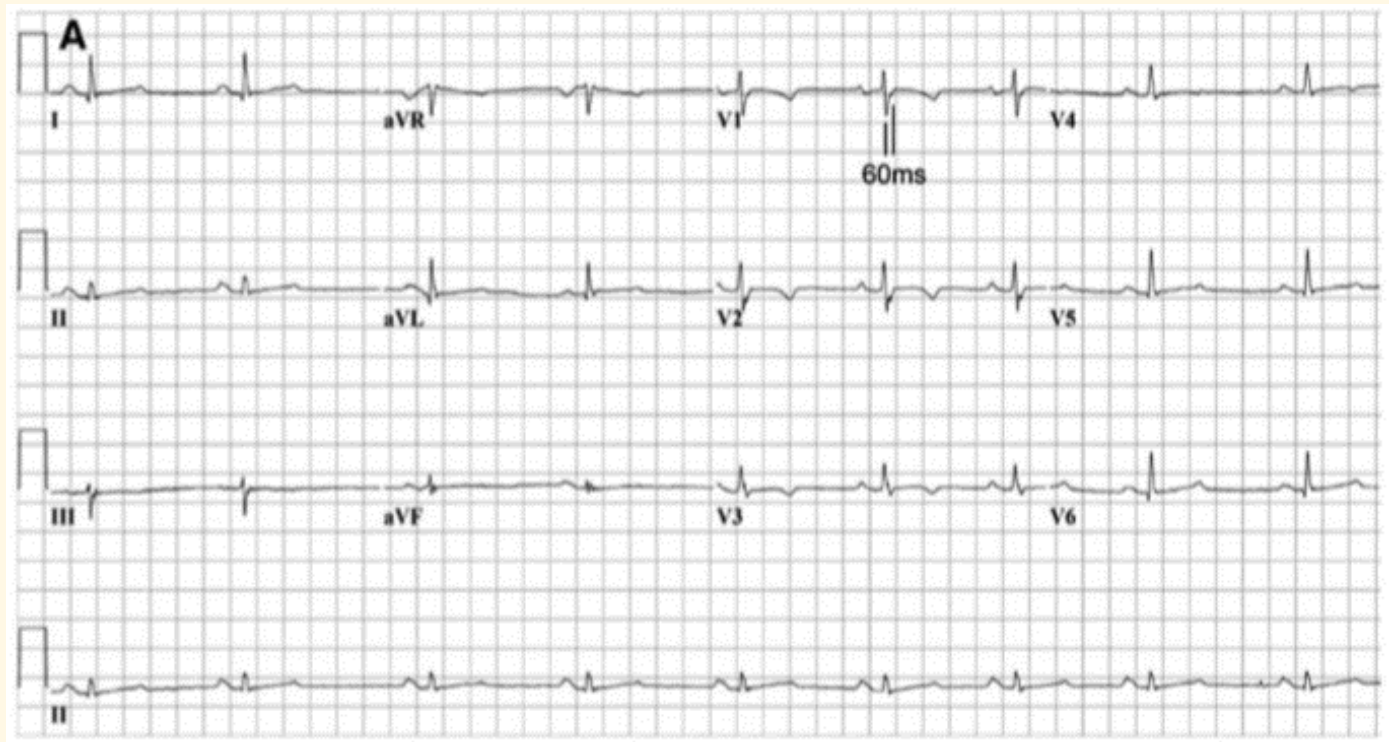
PAP: Pulmonary arterial pressure; CO: cardiac output; MPAP: mean PAP; PCWP: pulmonary artery capillary wedge pressure; PVR: pulmonary vascular resistance; RAP: right atrial pressure

Causes of RHF

	Decreased RV Contractility	RV Volume Overload	RV Pressure Overload
Acute	Sepsis		Acidosis
	LVAD support		Hypoxia
	RVMI	Excessive transfusion	PE
	Myocarditis		ARDS
	Perioperative injury/ischemia (postcardiotomy)		Positive pressure ventilation
Chronic	RV cardiomyopathy	LH disease	
	ARVC	Single ventricle	
	Ebstein anomaly		Pericardial disease
		PR	PAH
		TGA	Chronic thromboembolic PH
		TR	PS
			Left-sided valvular heart disease
			Restrictive cardiomyopathy

ARDS: acute respiratory distress syndrome; ARVC: arrhythmogenic right ventricular cardiomyopathy; LH: leftsided heart disease; LVAD: left ventricular assist device; PAH: pulmonary arterial hypertension; PE: pulmonary embolism; PH: pulmonary hypertension; PR: pulmonary regurgitation; PS: pulmonary stenosis; RHF: right-sided heart failure; RV: right ventricular; RVMI: right ventricular myocardial infarction; TGA: transposition of the great arteries; TR: tricuspid regurgitation.

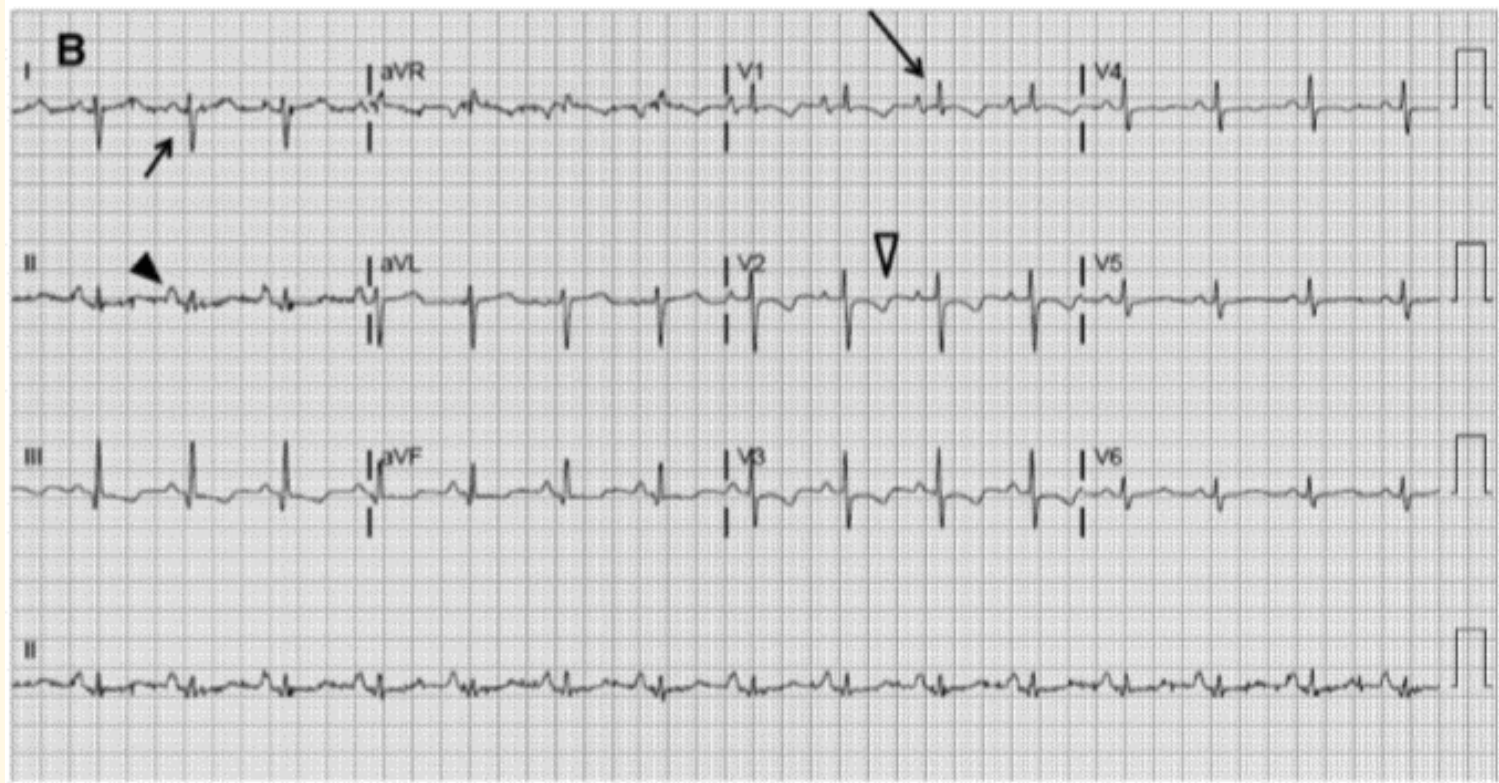
ECG in patients with right-sided heart disease



Arrhythmogenic right ventricular cardiomyopathy

- *T(-) in V1 → V4*
- *Prolongation of the terminal activation (nadir of S wave → end of QRS complex)*

ECG in patients with right-sided heart disease



Right ventricular hypertrophy

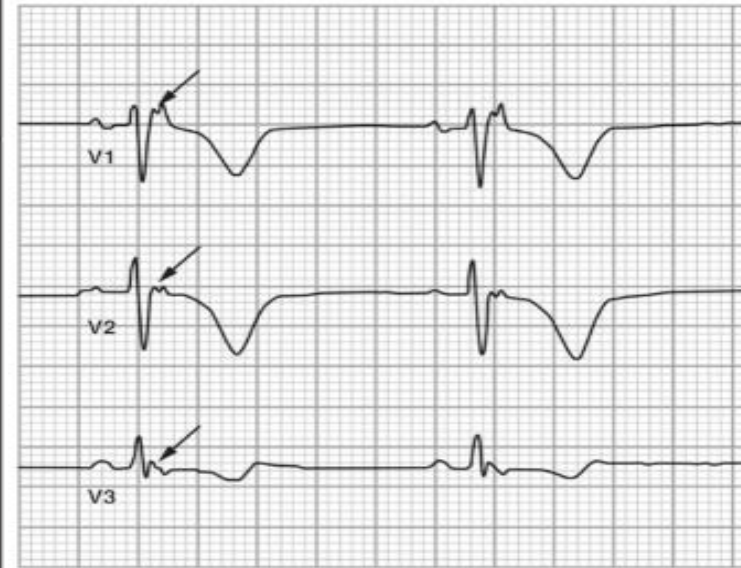
Criteria for ECG diagnosis of ARVC

Repolarization abnormalities	
Major	Inverted T waves in right precordial leads (V_1 - V_3) or beyond in individuals >14 y of age (in the absence of complete right bundle-branch block QRS \geq 120 ms)
Minor	Inverted T waves in leads V_1 and V_2 in individuals >14 y of age (in the absence of complete right bundle-branch block) or in V_4 , V_5 , or V_6 Inverted T waves in leads V_1 - V_4 in individuals >14 y of age in the presence of complete right bundle-branch block

ARVC: arrhythmogenic right ventricular cardiomyopathy; SAECG: signal-averaged ECG

Criteria for ECG diagnosis of ARVC

Depolarization/conduction abnormalities	
Major	Epsilon wave (reproducible low-amplitude signals between end of QRS complex and onset of the T wave) in the right precordial leads (V_1 - V_3)
Minor	Late potentials by SAECG in ≥ 1 of 3 parameters in the absence of a QRS duration ≥ 110 ms on the standard ECG Filtered QRS duration ≥ 114 ms Duration of terminal QRS < 40 μ V (low-amplitude signal duration) ≥ 38 ms Root-mean-square voltage of terminal 40 ms ≤ 20 μ V Terminal activation duration of QRS ≥ 55 ms measured from the nadir of the S wave to the end of the QRS, including R, in V_1 , V_2 , or V_3 , in the absence of complete right bundle-branch block



ARVC: arrhythmogenic right ventricular cardiomyopathy; SAECG: signal-averaged ECG
Mũi tên: epsilon wave

Classification of PH

PH Category	Characteristics	Clinical Group
Precapillary	MPAP \geq 25 mmHg PCWP \leq 15 mmHg	WHO class 1, 3–5
Postcapillary	MPAP \geq 25 mmHg PCWP $>$ 15 mmHg	WHO class 2, 5
Isolated postcapillary PH	DPG $<$ 7 mmHg and/ or PVR \leq 3 WU	
Combined precapillary and postcapillary PH	DPG \geq 7 mmHg and/ or PVR $>$ 3 WU	

DPG: diastolic pulmonary gradient; MPAP: mean pulmonary artery pressure; PCWP: pulmonary capillary wedge pressure; PH: pulmonary hypertension; PVR: pulmonary vascular resistance; WHO, World Health Organization; WU: Woods units

DPG= PA diastolic pressure – PCWP

Chronic lung disease: precapillary PH

Classification of PH (1)

Group 1: Pulmonary Arterial Hypertension

Precapillary PH:

- Idiopathic PAH
- Hereditary PAH
- Drugs, toxins
- Connective tissue disease
- Portal hypertension
- HIV
- CHD with persistent pulmonary to systemic shunt
- Eisenmenger physiology
- Schistosomiasis
- Persistent PAH of the newborn
- Pulmonary veno-occlusive disease
- Pulmonary capillary hemangiomatosis

Classification of PH (2)

Group 2: Left heart disease

- DPG \geq 7 mmHg: pulmonary vascular disease superimposed on left-sided pressure elevation
- DPG $<$ 7 mmHg: isolated postcapillary PH

Group 3: Chronic lung disease and Hypoxia

Group 4: Chronic Thromboembolic Disease

Group 5: Miscellaneous

- Sarcoidosis; chronic hemolytic disorders; chronic kidney disease
- Myocardial depression during sepsis
- ARDS; mechanical ventilation

Manifestations of RHF (1)

Clinical manifestations of RHF
Increased mortality
Fatigue/decreased functional capacity
Cardiorenal abnormalities
Cardiohepatic abnormalities
Protein malnutrition
Coagulopathy
Cachexia

LLSB: left lower sternal border; PH: pulmonary hypertension; RHF: right-sided heart failure; RV: right ventricular; TR: tricuspid regurgitation

Manifestations of RHF (2)

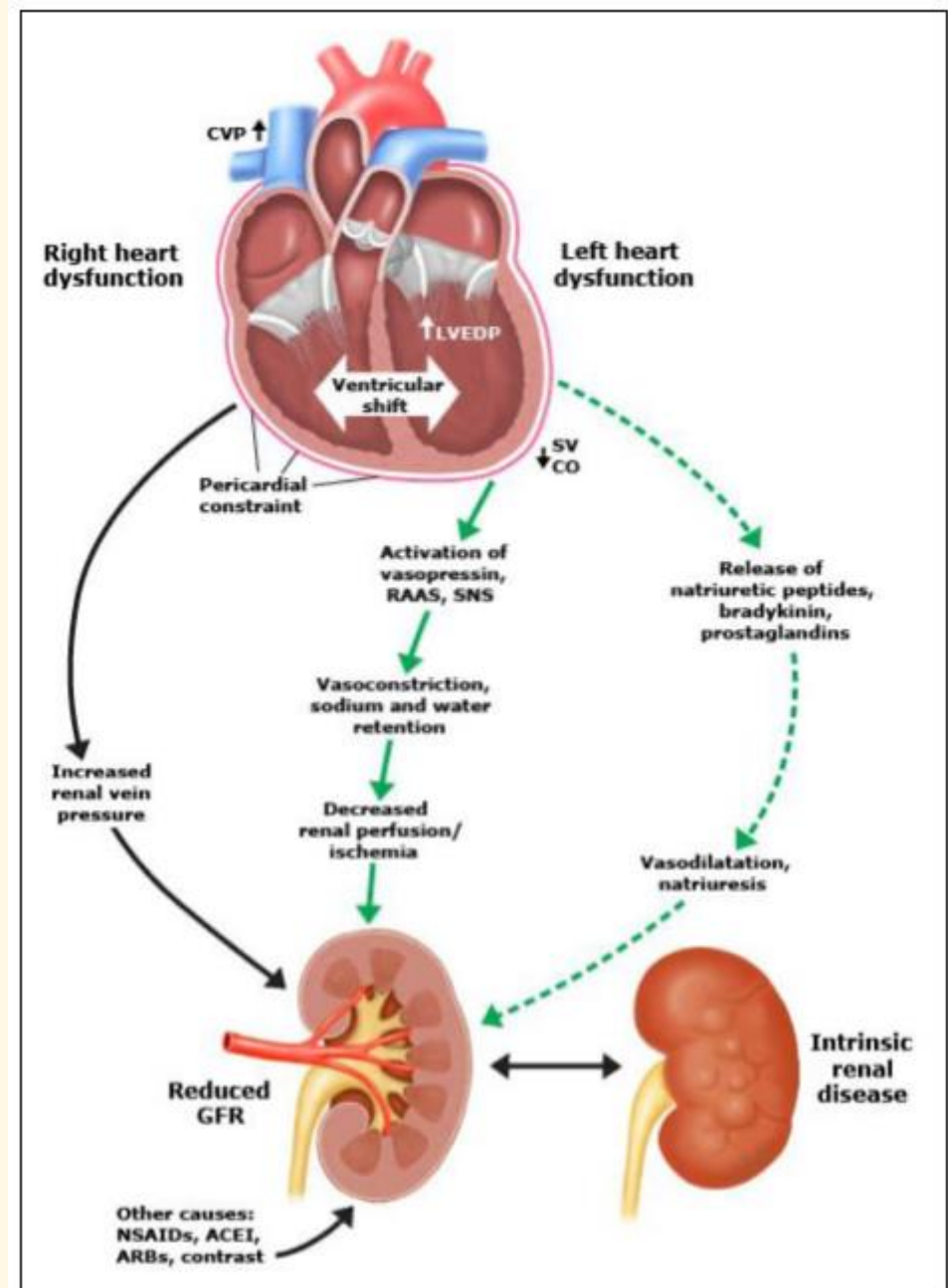
Signs and symptoms
Elevated jugular venous pressure with prominent V wave
Peripheral edema
Bloating/early satiety/abdominal discomfort
Ascites and hepatomegaly
Pleural effusion
Prominent S ₂ (P ₂) (PH)
Right-sided S ₃ gallop
Holosystolic murmur LLSB (TR)
RV parasternal heave

LLSB: left lower sternal border; PH: pulmonary hypertension; RHF: right-sided heart failure; RV: right ventricular; TR: tricuspid regurgitation

Pathophysiology of cardiorenal disease

(Acute decompensated HF leading to kidney injury)

CO: cardiac output; CVP: central venous pressure; LVEDP: left ventricular end-diastolic pressure; RAAS: renin-angiotensin-aldosterone system; SNS: sympathetic nervous system; SV: stroke volume



Clinical manifestation of RHF

❖ Acute RHF:

- Acute RV dilatation
- Signs of hypoperfusion and hypotension (diaphoresis, listlessness, cyanosis, cool extremities, hypotension, and tachycardia)
- Shortness of breath, atrial and ventricular arrhythmias

❖ Chronic RHF:

- Cardiorenal syndrome
- Cardiohepatic syndrome
- Gastrointestinal involvement

Evaluation of RHF

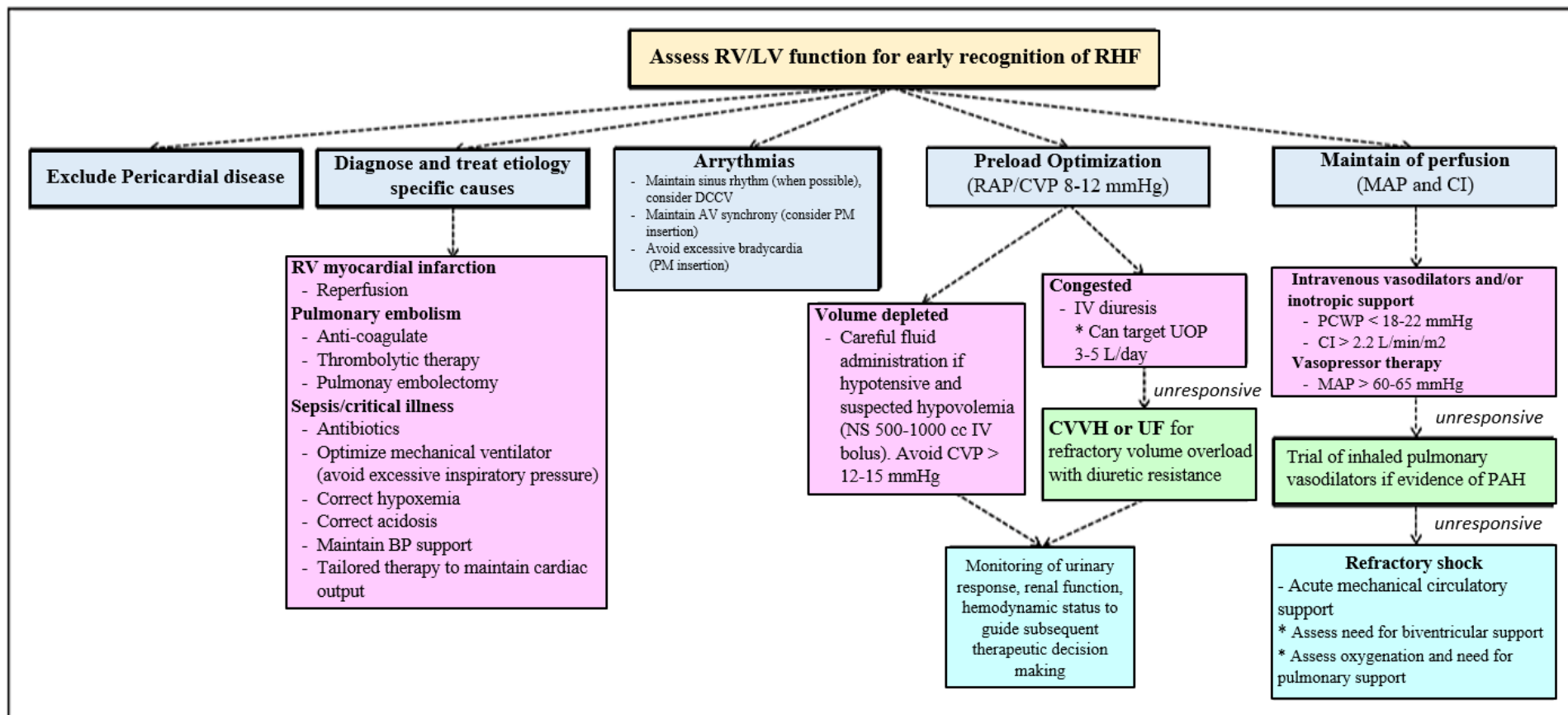
- ❖ Physical examination
- ❖ ECG
- ❖ Serum markers:
 - Transaminases
 - ↓ Albumin
 - ↑ INR
 - ↑ Bilirubin
- ❖ Echocardiography
- ❖ Cardiac MRI
- ❖ MSCT
- ❖ Radionuclide Imaging
- ❖ Chest X-ray
- ❖ Biomarkers/RV function: NT-ProBNP, BNP

Hemodynamic Assessment of RH Function

Hemodynamic Parameters Associated With RV Function		
Variable	Calculation	Thresholds associated with Clinical Events in Specific Populations
RAP	RAP (or CVP)	> 15 mmHg (RHF after LVAD)
Right-to-left discordance of filling pressures	RAP:PCWP	> 0.63 (RHF after LVAD) > 0.86 (RHF in acute MI)
PA pulsatility index	$(PASP - PADP) / RAP$	<1.0 (RHF in acute MI) 203 <1.85 (RHF after LVAD)
RV stroke work index	$(MPAP - CVP) \times SVI$	<0.25–0.30 mm Hg·L/m ² (RHF after LVAD)
PVR	$(MPAP - PCWP) / CO$	>3.6 WU (RHF after LVAD)
PA compliance	$SV / (PASP - PADP)$	<2.5 mL/mm Hg (RHF in chronic HF, RV-PA coupling in PAH)

LVAD: left ventricle assist device; CVP: central venous pressure

Management of acute right-sided HF



Stepped Pharmacological Care (1)

Stepped Pharmacological Care Treatment Algorithm
UO goals to be assessed daily from randomization to 96 h
UO >5 L/d → reduce current diuretic regimen if desired
UO 3–5 L/d → continue current diuretic regimen
UO <3 L/d → see diuretic grid
24-h assessment
UO recommendations as above
Advance to next step on grid if UO <3 L/d
48-h assessment
UO recommendations as above
Advance to next step on grid if UO <3 L/d
Consider dopamine or dobutamine at $2 \mu\text{g}\cdot\text{kg}^{-1}\cdot\text{h}^{-1}$ if SBP <110 mmHg and EF <40% or RV systolic dysfunction
Consider nitroglycerin or nesiritide if SBP >120 mmHg (any EF) and severe symptoms

LVAD: left ventricular assist device; UO: urine output

Stepped Pharmacological Care (2)

72- and 96-h assessments		
UO recommendations as above		
Advance to next step on grid if UO <3 L/d		
Consider dopamine or dobutamine at 2 $\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{h}^{-1}$ if SBP <110 mmHg and EF <40% or RV systolic dysfunction		
Consider nitroglycerin or nesiritide if SBP >120 mmHg (any EF) and severe symptoms		
Consider hemodynamic-guided IV therapy, LVAD, dialysis, or ultrafiltration crossover		
Diuretic Grid		
	Suggested Dose	
Current Dose	Daily Loop Dose	Thiazide
A <80 mg	40 mg IV bolus 5 mg/h	None
B 81–160 mg	80 mg IV bolus+10 mg/h	5 mg metolazone once daily
C 161–240 mg	80 mg IV bolus+20 mg/h	5 mg metolazone twice daily
D >240 mg	80 mg IV bolus+30 mg/h	5 mg metolazone twice daily

LVAD: left ventricular assist device; UO: urine output

Medical management of ARHF

- ❖ Volume management
 - Diuretics
 - Renal Replacement Therapies
- ❖ Vasoactive Therapies
 - Afterload Reduction
 - Augment Contractility
- ❖ Maintain Perfusion

Medical management of CRHF

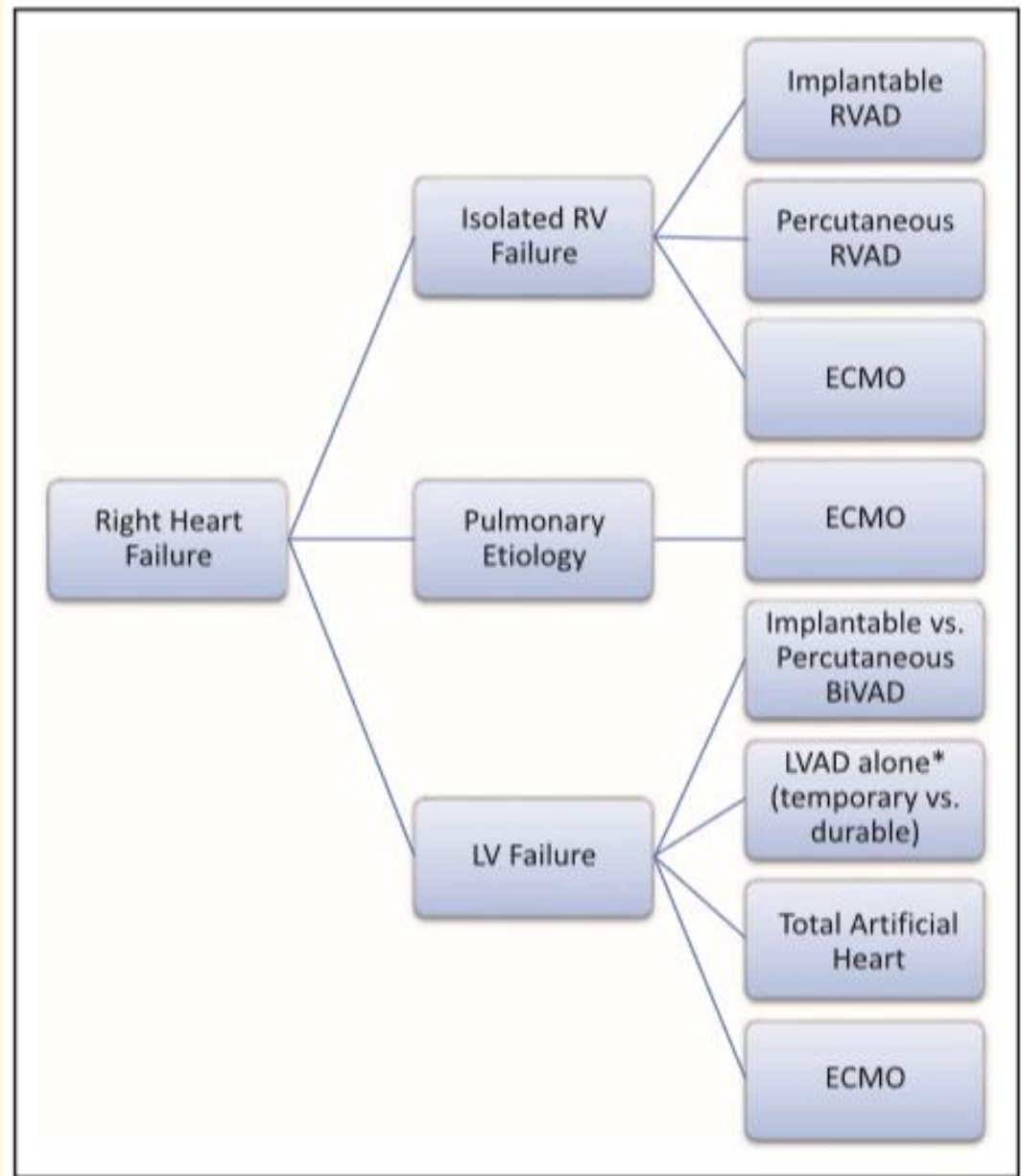
- ❖ Diuretics and Sodium Restriction
- ❖ RAAS inhibitors, β -Blockers, Hydralazine
- ❖ Digoxin
- ❖ Pulmonary Vasodilators
 - Prostacyclin Analogs
 - PDE-5 inhibitors
 - Endothelin Receptor Antagonists

Management of CRHF in Congenital Heart Disease (CHD)

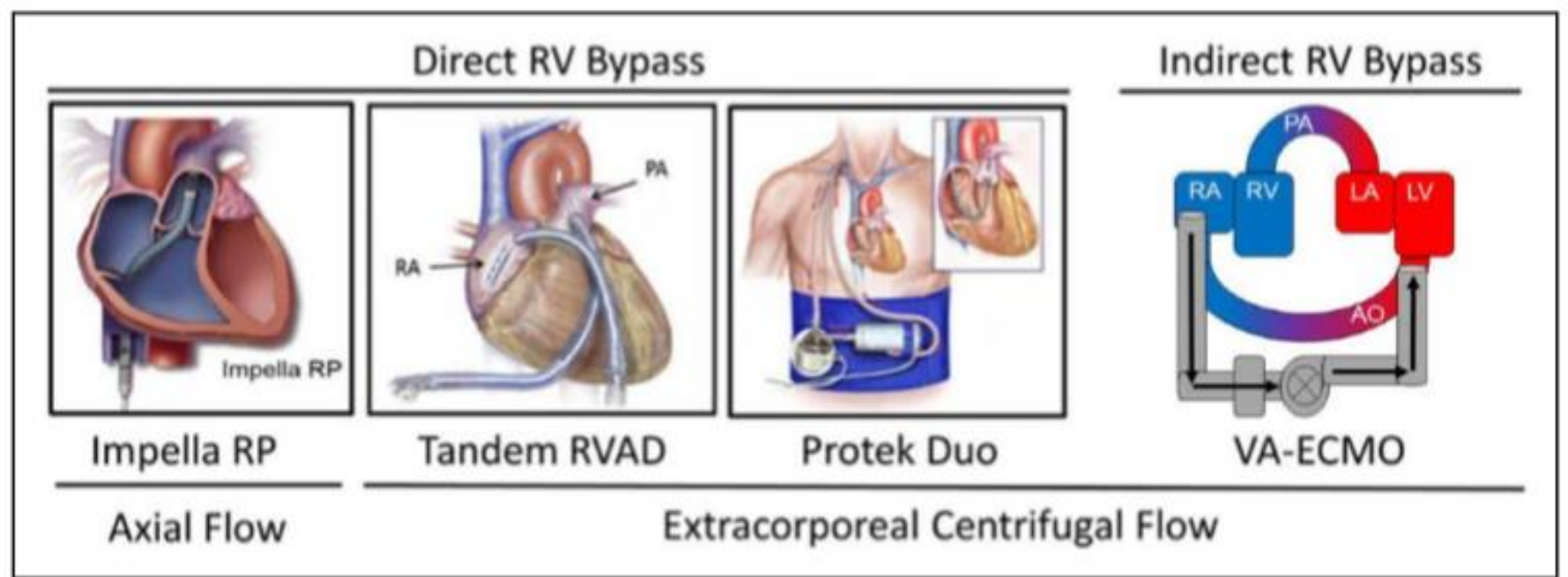
- ❖ Standard HF drugs: non-efficacy in single RV, systemic RV or pulmonary RV (eg. after TOF surgery)
- ❖ Individualized treatment by specialist in CHD and HF
- ❖ Heart or lung transplantation

MCS and Transplantation for RHF

MCS: Mechanical circulatory support;
BiVAD: biventricular assist device; ECMO:
extracorporeal membrane support; LVAD:
left ventricular assist device; RVAD: right
ventricular assist device



MCS options for acute RV support



RVAD: right ventricular assist device; VAECMO: veno-arterial extracorporeal membrane oxygenation

Indications for surgery for TR

