

Management of RV failure, the forgotten ventricle

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Disclosures

- Speaker for MERCK.

Objectives

- Examine the anatomy of the RV
 - Review the physiology and pathophysiology of the right ventricle (RV)
 - List various situations that may result in right heart failure (RHF)
 - Launch a discussion on the treatment of acute RHF (ARHF)
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- For purposes of this discussion, there is overlap between chronic and acute, but we will focus on ARHF.

It really *was* the forgotten ventricle

689 articles before
1972
>22K since 1/1/00

The screenshot shows the PubMed.gov search interface. At the top, the NIH National Library of Medicine logo is visible. The search bar contains the query: "right ventricle" OR "right heart failure" OR "RHF". Below the search bar, there are buttons for "Advanced", "Create alert", and "Create RSS". The search results section shows "30,542 results" and a "Sorted by: Publication date" dropdown. A "RESULTS BY YEAR" chart is on the left, showing a significant increase in publications starting around 2000. The first result is titled "Case of aneurism of the ascending aorta, bursting into the **right ventricle**; with a communication between the two ventricles." by Beck TS. The PMID is 20895743, and it is marked as a "Free PMC article". The second result is titled "Case of Rupture of the **Right Ventricle** of the Heart." by Challice J. The PMID is 10.1136/bmi.s1-7.164.126.

> 30 X more
articles in the
last 20 years

It really *was* the forgotten ventricle

11,234 before 1972

216 K since 1/1/00

The screenshot shows the PubMed.gov search interface. At the top, the NIH National Library of Medicine logo is visible. The search bar contains the query: "left ventricle" OR "left heart failure" OR "HFREF" OR "systolic heart failure". Below the search bar, the results are displayed. A red box highlights the search query, and another red box highlights the result count: 285,576 results. The first result is titled "Observations on Sudden Deaths Occasioned by a Rupture of the **Left Ventricle** of the **Heart**." and is circled in red. The second result is titled "History of a Disease from Thickened and Cartilaginous Valves of the **Left Ventricle**, and of the Semilunar Valves of the Aorta." The page also shows a "RESULTS BY YEAR" chart and navigation controls.

NIH National Library of Medicine
National Center for Biotechnology Information

Log in

PubMed.gov

"left ventricle" OR "left heart failure" OR "HFREF" OR "systolic heart failure"

Search

Advanced Create alert Create RSS User Guide

Save Email Send to Sorted by: Publication date ↑ Display options

MY NCBI FILTERS

285,576 results

Page 1 of 1,428

RESULTS BY YEAR

1788 2023

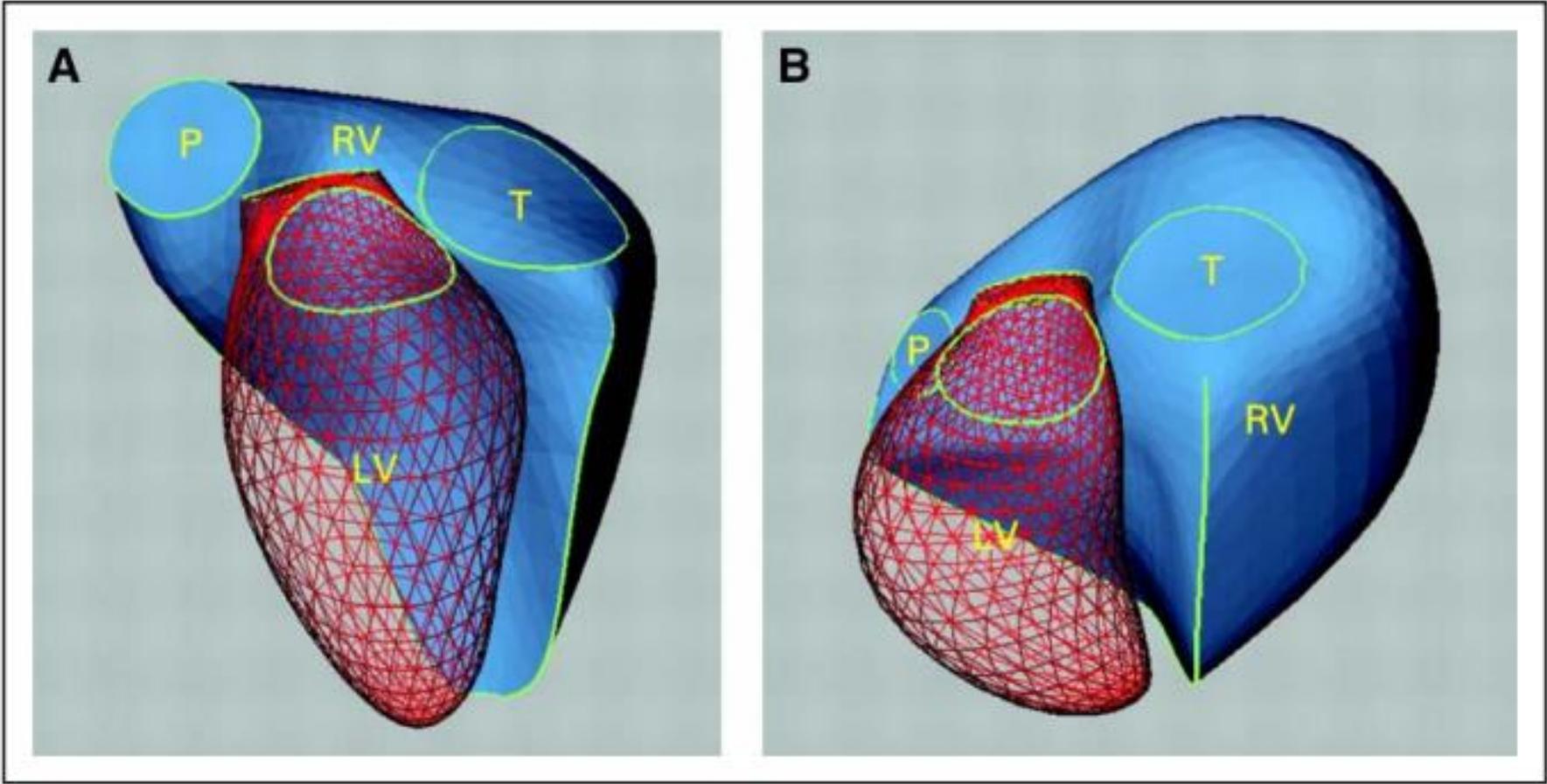
TEXT AVAILABILITY

Observations on Sudden Deaths Occasioned by a Rupture of the **Left Ventricle** of the **Heart**.
1
Cite Portal M.
Lond Med J. 1788;9(Pt 2):156-179.
Share PMID: 29739723 Free PMC article. No abstract available.

History of a Disease from Thickened and Cartilaginous Valves of the **Left Ventricle**, and of the Semilunar Valves of the Aorta.
2
Cite Pearson G.

19 X more
articles in the
last 20 years

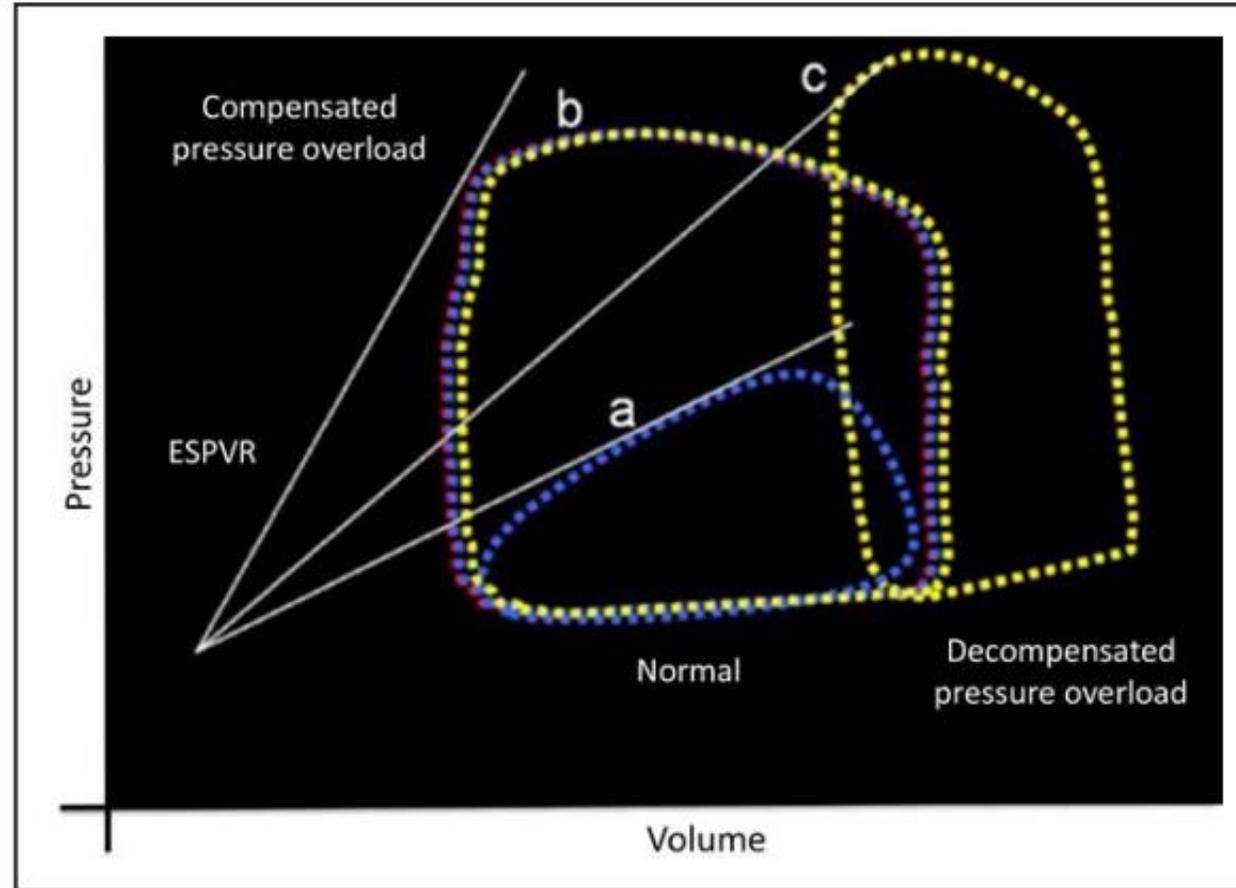
Anatomically Complex RV



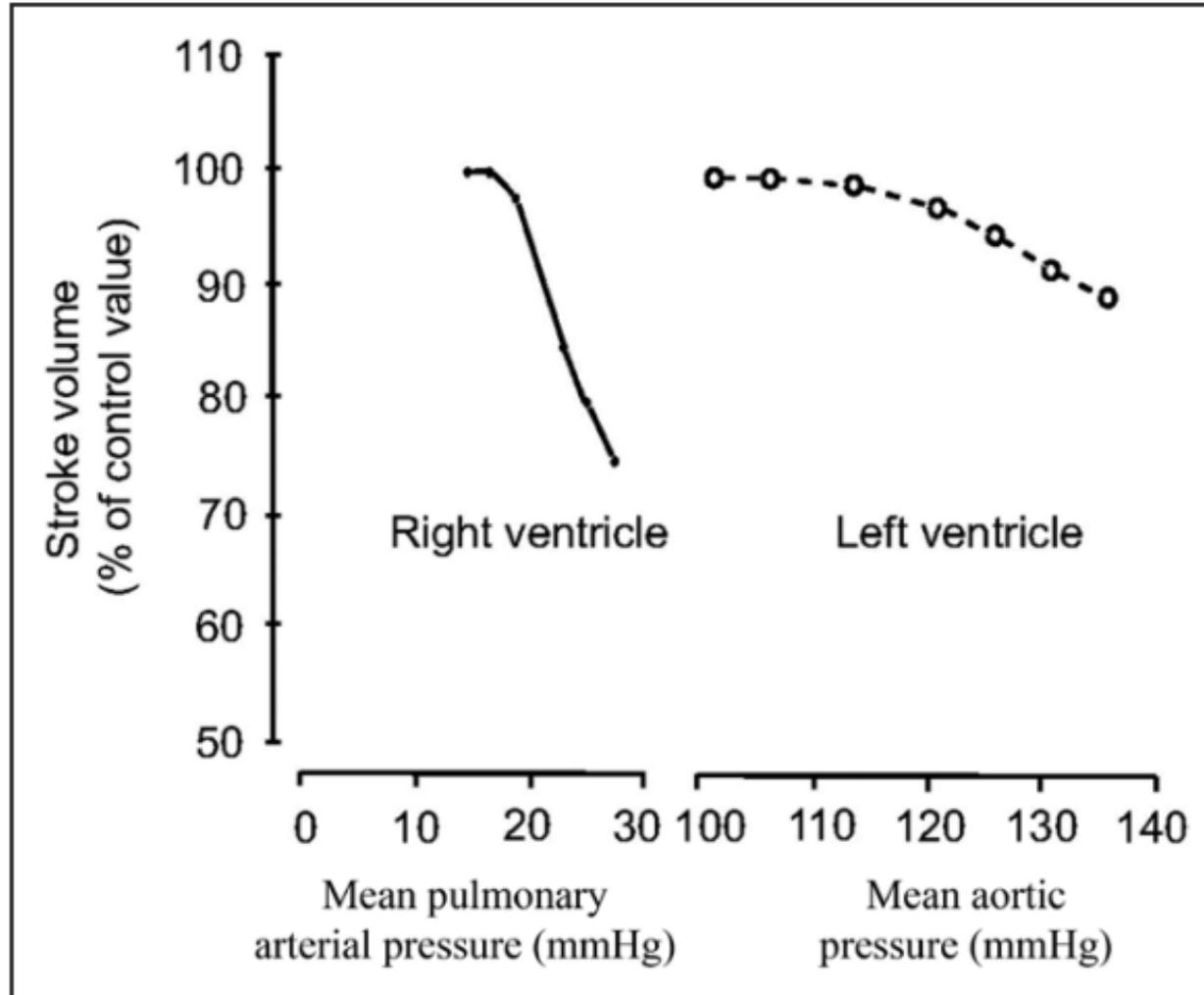
Physiology

- Systemic venous return
- RV afterload or PA load
- Pericardial compliance
- Native contractility of the RV free wall
- Native contractility of the interventricular septum

PV Loops



Acute Afterload Change



Pathophysiology RV Afterload

- RVSP and PASP usually with no more than a 5 mm Hg gradient
- Pulmonary vascular resistance $((mPAP - PCWP)/CO)$
- Pulmonary vasculature can result in retrograde flow in the PA so RV afterload not always accounted for by the PVR calculation
 - Interestingly elevated LAP, pulmonary *venous* hypertension, affects pulmonary compliance

Pathophysiology

- Reduction in LAP, or PCWP, significantly increases pulmonary arterial compliance more than drop in PVR alone.
 - Important in managing LHF for both RVF and PH*
- RV perfusion occurs during systole and diastole
 - Decreased transmural pressure gradient in RV pressure overload states + decreased systemic pressures → RV ischemia
 - Increased RVEDP → Decreased pressure gradient in RV volume overload states → RV ischemia
 - RV pressure overload → coronary sinus congestion → RV ischemia

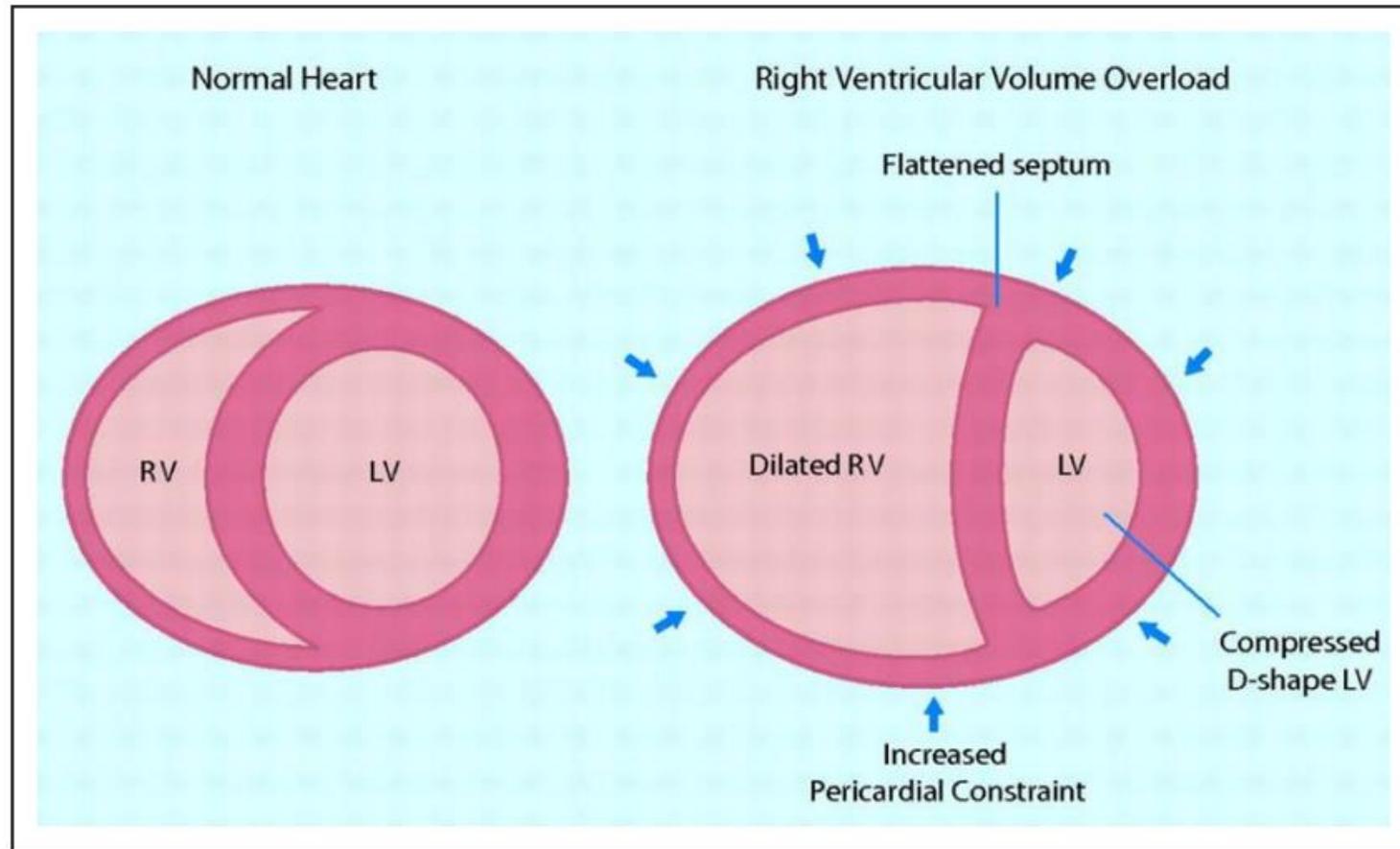
Acute RHF

- Abrupt change in RV afterload
 - Pulmonary embolus
 - Hypoxia
 - Acidemia
- Abrupt change in RV contractility
 - RV ischemia
 - Myocarditis
 - Post cardiotomy shock; not always manifest as shock

Acute 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

Ventricular – interdependent LV filling

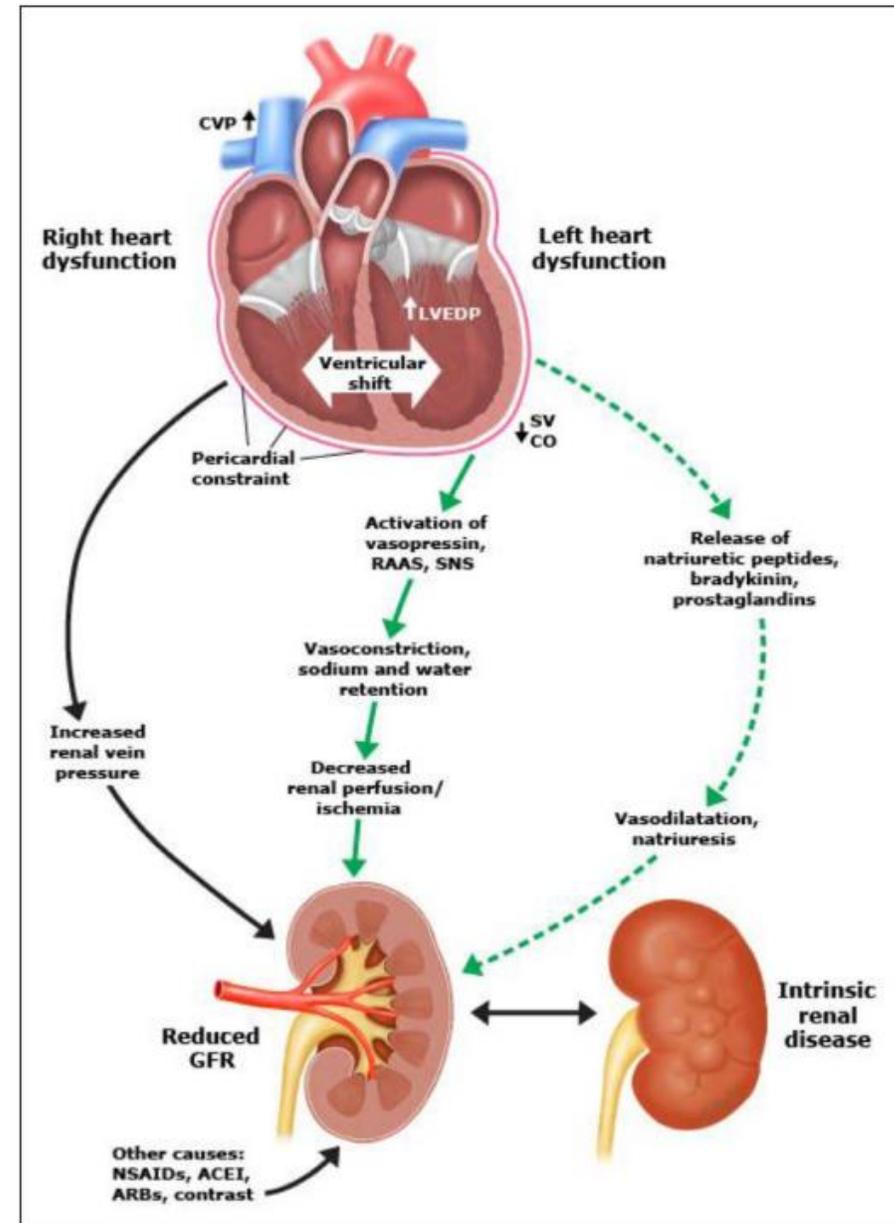


Clinical Recognition

- Physical examination
 - Cachexia
 - Peripheral edema, anasarca
 - Jugular venous distention
 - Hepatojugular reflex
 - Perfusion issues
 - Prominent split P2 in PH
 - Precordial heave
 - *narrow pulse pressure difference

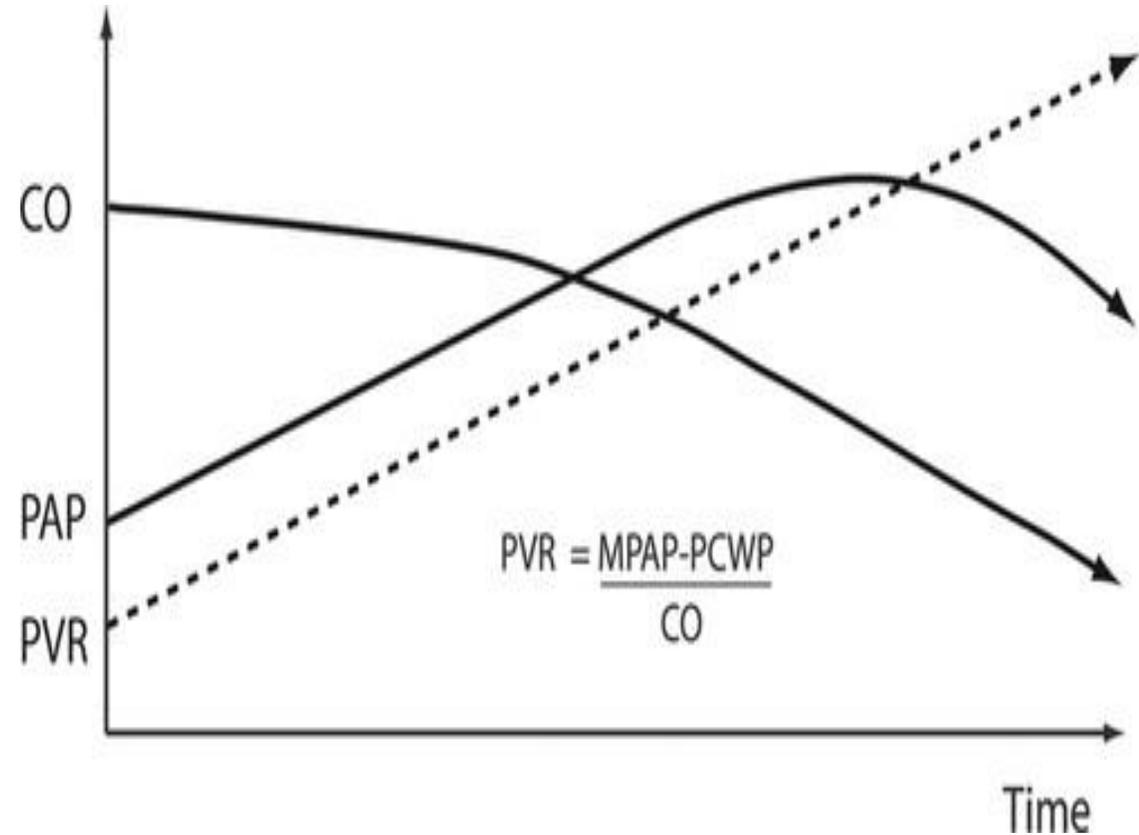
Clinical recognition

- Transaminitis
- Elevated total bilirubin
- Cardiorenal syndrome



Echocardiography

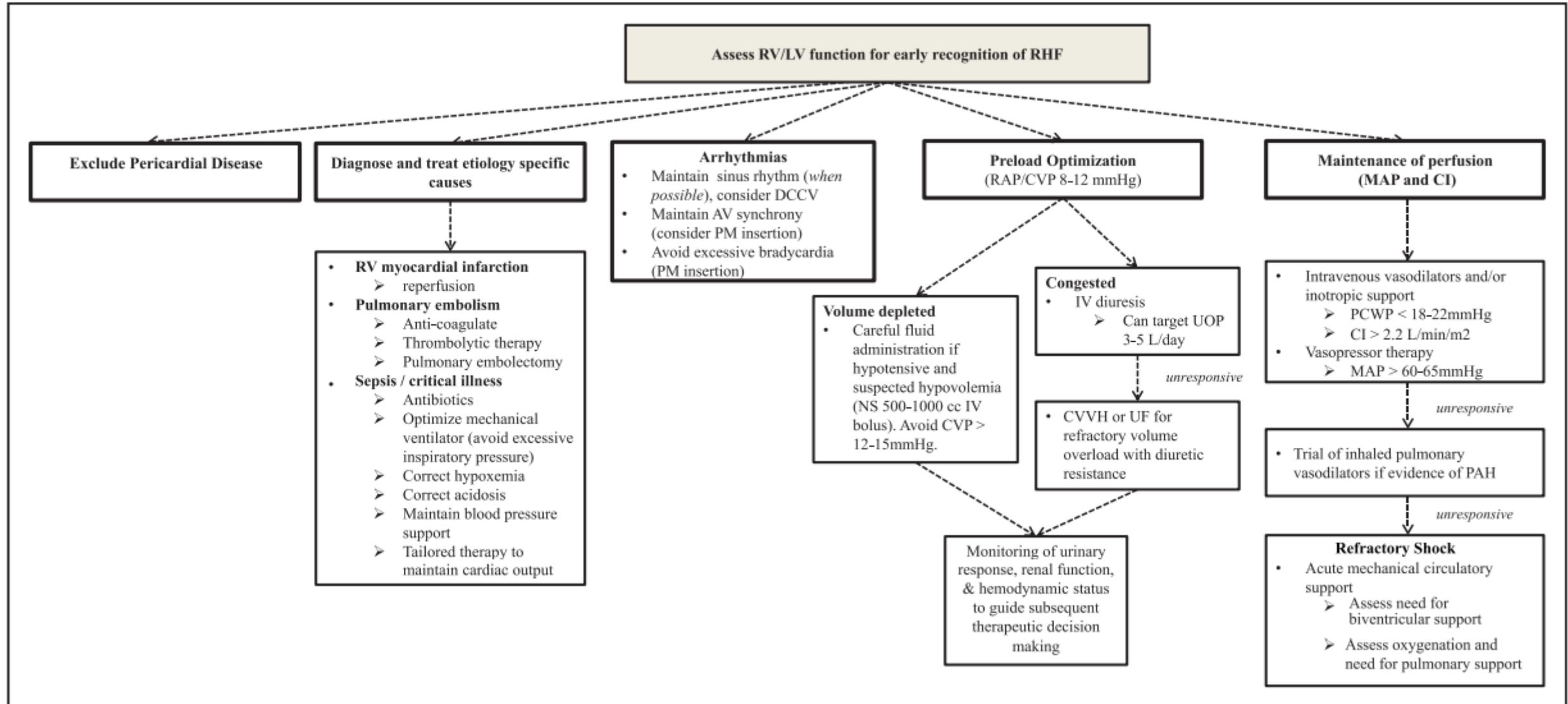
- RVEDD > 4.2
- RV area dimension > LV area dimension
- TAPSE \geq 1.7 cm
- TDI s' < cm/s
- In shock, don't be fooled by low RVSP on echo
- Septal bowing leftward
- IVC measurements
- Hepatic vein flow reversal



Hemodynamic Assessment

Hemodynamic Parameters Associated With RV Function		
Variable	Calculation	Thresholds Associated With Clinical Events in Specific Populations
RAP	RAP (or CVP)	>15 mm Hg (RHF after LVAD) ^{83,201}
Right-to-left discordance of filling pressures	RAP:PCWP	>0.63 (RHF after LVAD) ⁷⁶ >0.86 (RHF in acute MI) ²⁰²
PA pulsatility index	$(\text{PASP} - \text{PADP}) / \text{RAP}$	<1.0 (RHF in acute MI) ²⁰³ <1.85 (RHF after LVAD) ²⁰⁴
RV stroke work index	$(\text{MPAP} - \text{CVP}) \times \text{SVI}$	<0.25–0.30 mm Hg·L/m ² (RHF after LVAD) ^{205,206}
PVR	$(\text{MPAP} - \text{PCWP}) / \text{CO}$	>3.6 WU (RHF after LVAD) ²⁰⁷
PA compliance	$\text{SV} / (\text{PASP} - \text{PADP})$	<2.5 mL/mm Hg (RHF in chronic HF, RV-PA coupling in PAH) ^{26,115}

Management of Acute RHF



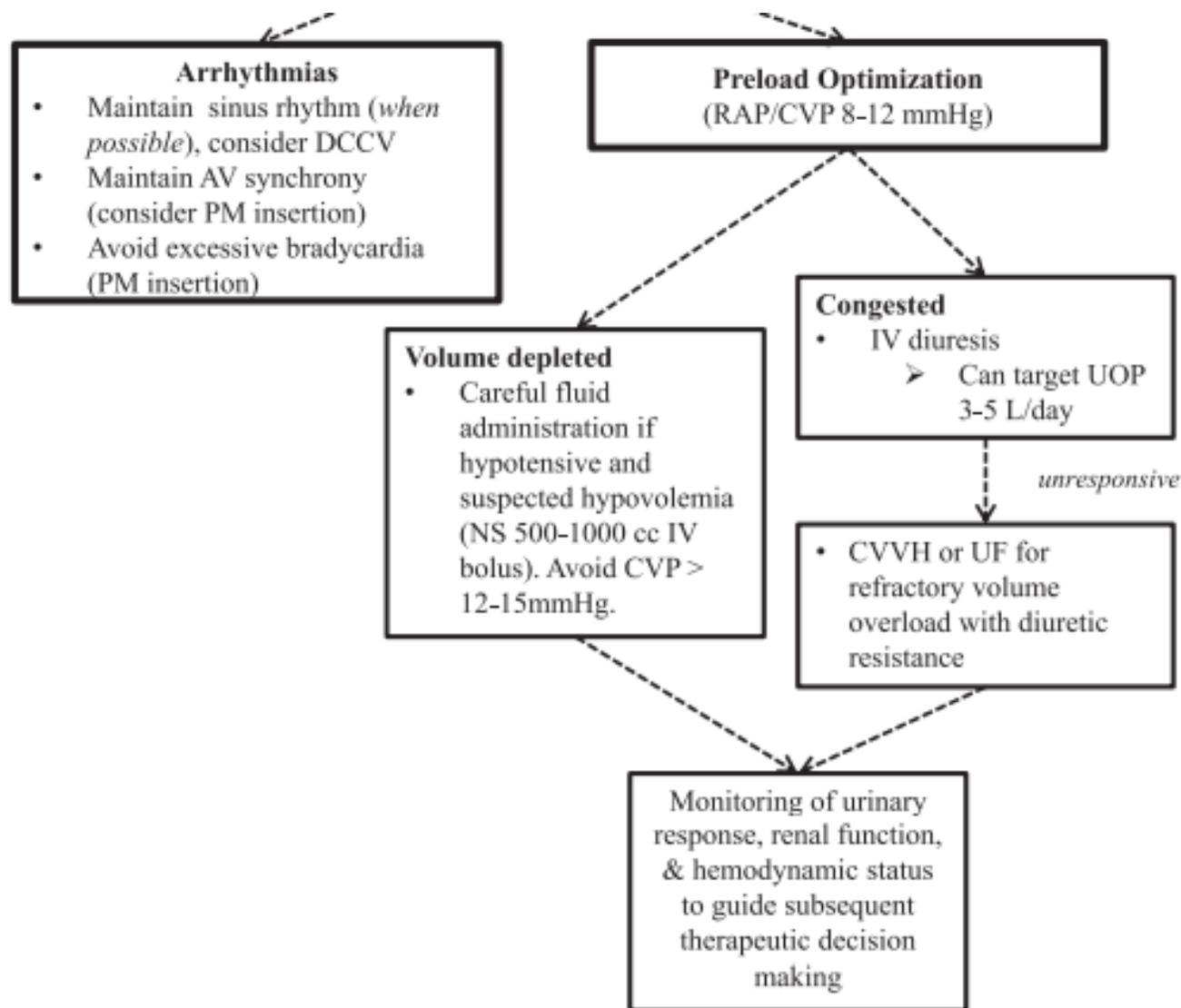
First, determine the etiology

Exclude Pericardial Disease

Diagnose and treat etiology specific causes

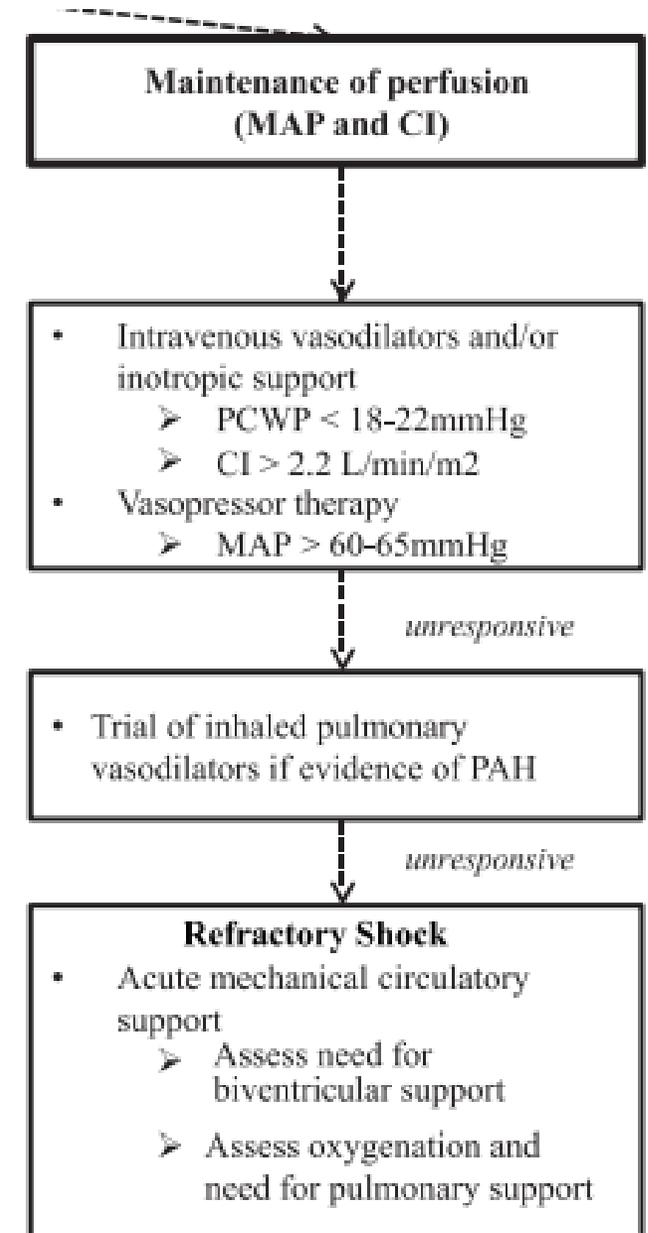
- **RV myocardial infarction**
 - reperfusion
- **Pulmonary embolism**
 - Anti-coagulate
 - Thrombolytic therapy
 - Pulmonary embolectomy
- **Sepsis / critical illness**
 - Antibiotics
 - Optimize mechanical ventilator (avoid excessive inspiratory pressure)
 - Correct hypoxemia
 - Correct acidosis
 - Maintain blood pressure support
 - Tailored therapy to maintain cardiac output

Control for arrhythmias and preload issues

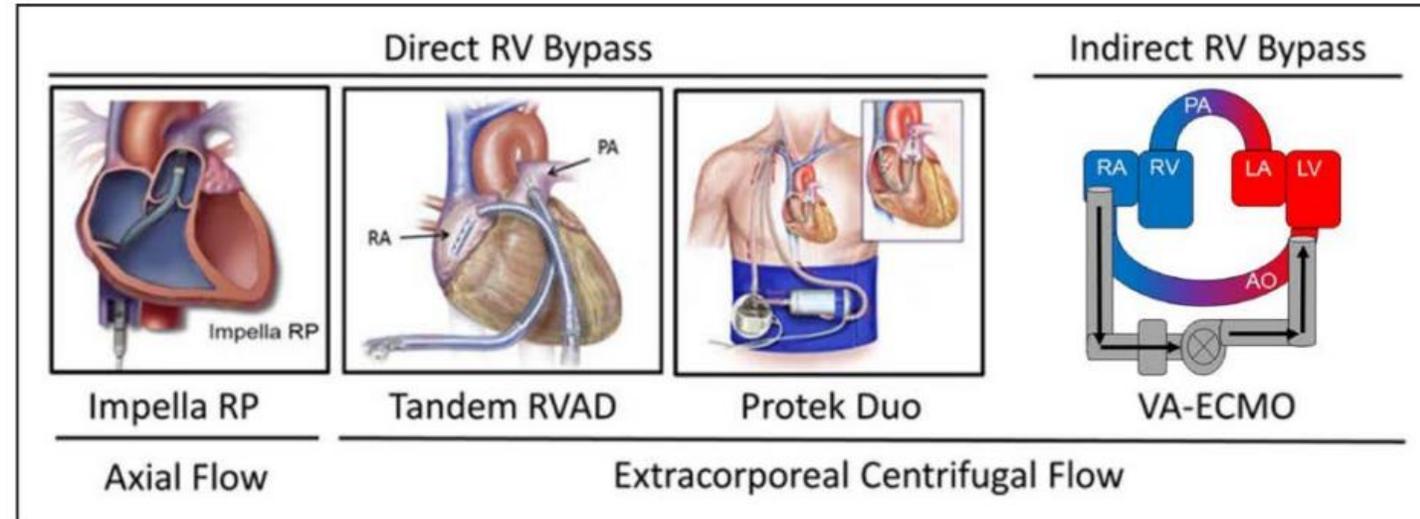
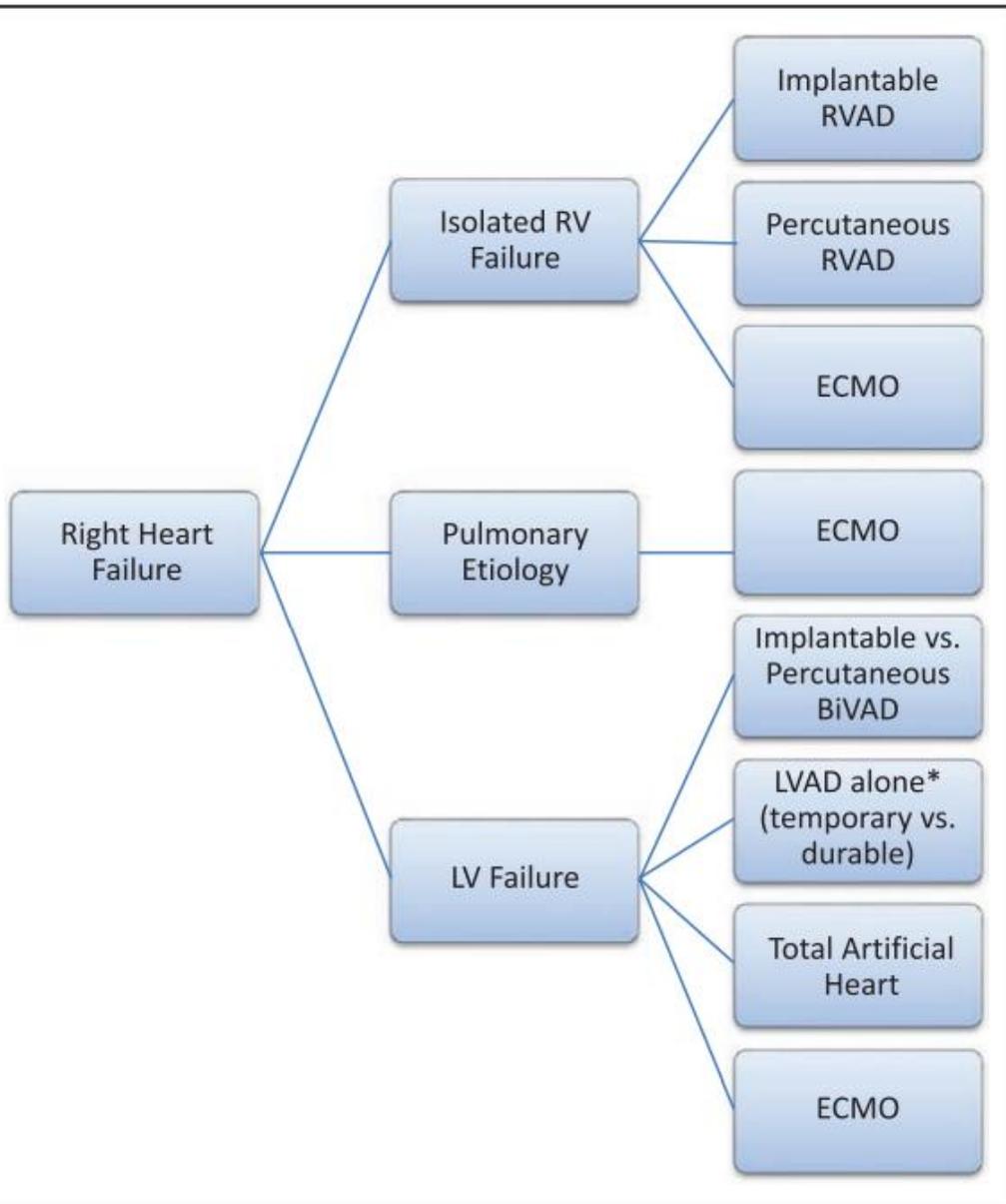


Focus on contractility and afterload

- Vasoactive agents
 - Inotropes –
 - Milrinone
 - Dobutamine
 - Inopressors –
 - Dopamine
 - Levophed
 - Epinephrine
 - Pressors –
 - Vasopressin
 - Neosynephrine
- IV Vasodilators
- Inhaled versus IV pulmonary vasodilators
 - (orals not typically used acutely)



Refractory Shock



Summary

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Take Homes

- The RV is no longer forgotten, so we can't forget it either.
- When the RV is involved, it makes everything more tricky.
- Prognostically, identification and management of any RHF is crucial.
- Identification can be easy if you are looking for it.
- Management is quite involved but if it happens early enough, we can mitigate down stream issues.

THANK YOU



P.S. My real bosses