Management of RV failure, the forgotten ventricle

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Disclosures

- Speaker for MERCK.

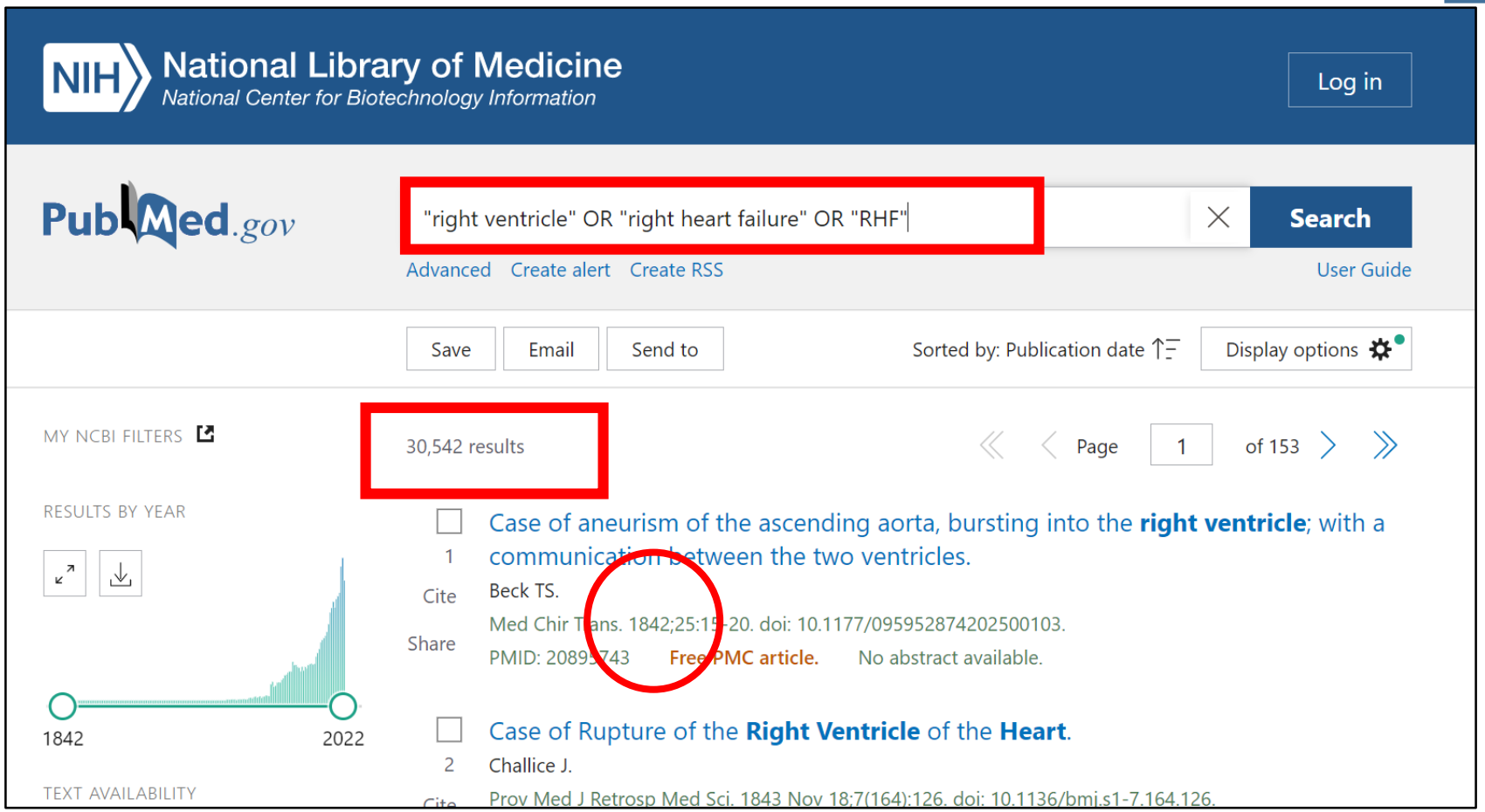
Objectives

- 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)

- 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

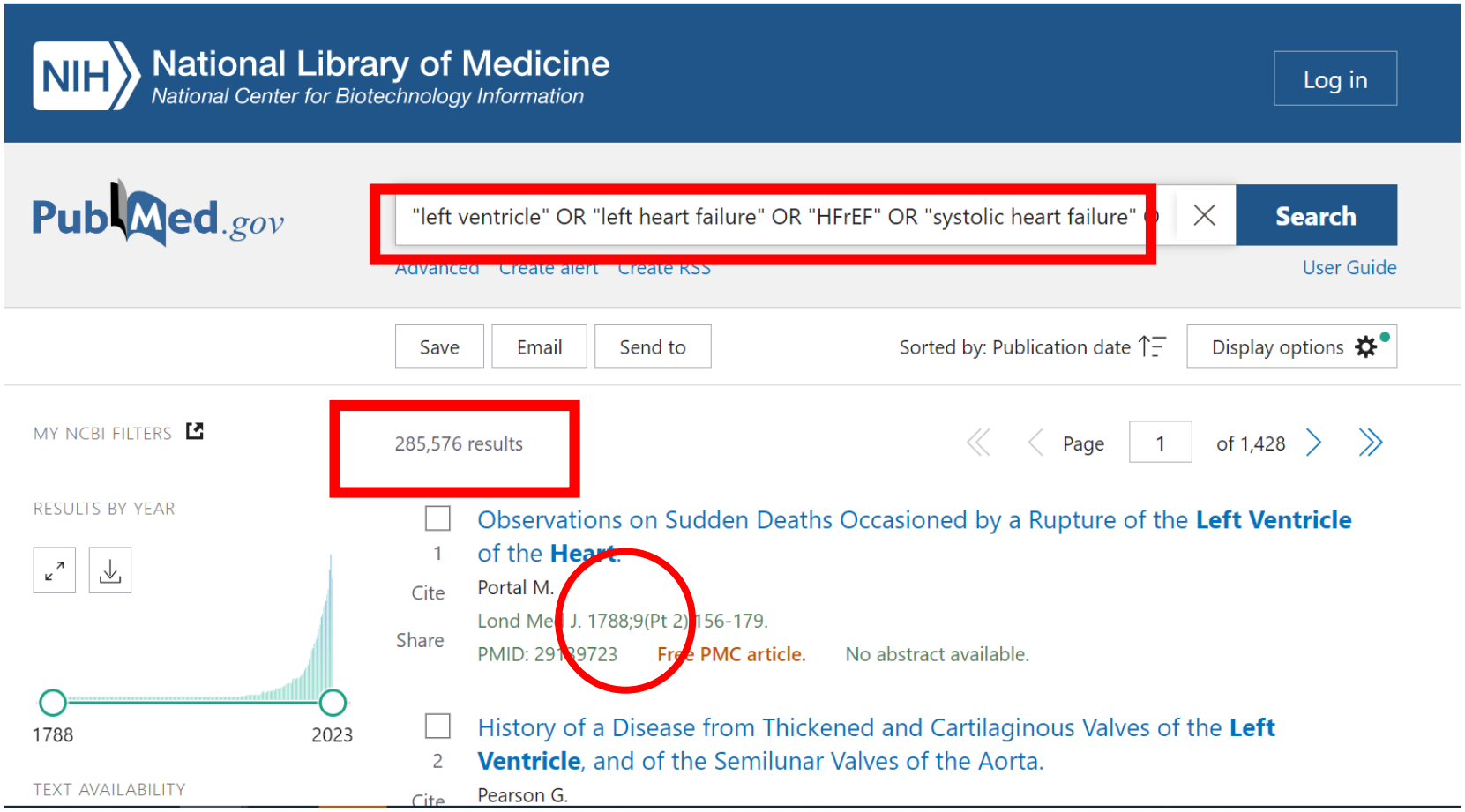


> 30 X more articles in the last 20 years

It really *was* the forgotten ventricle

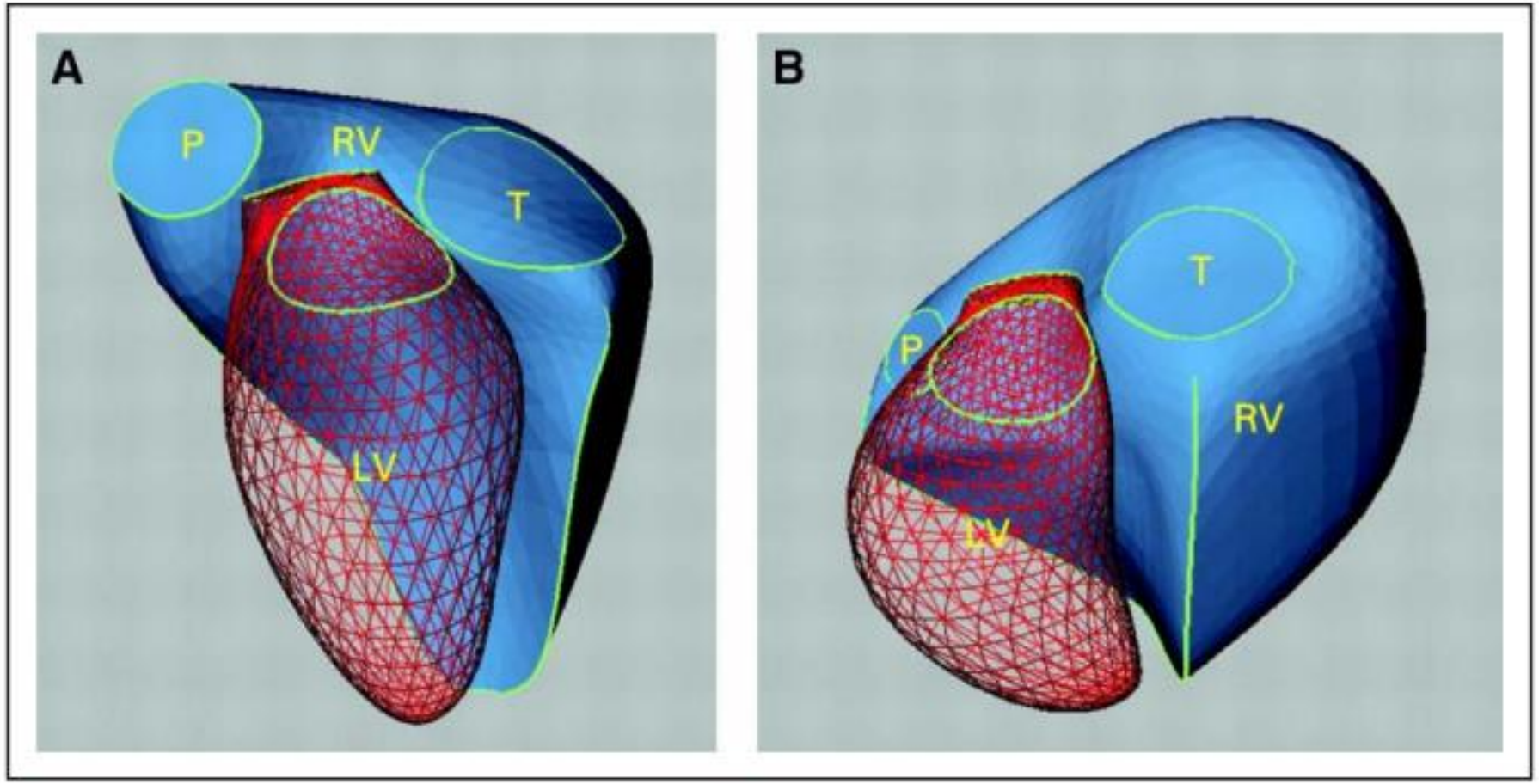
11,234 before 1972

216 K since 1/1/00



19 X more articles in the last 20 years

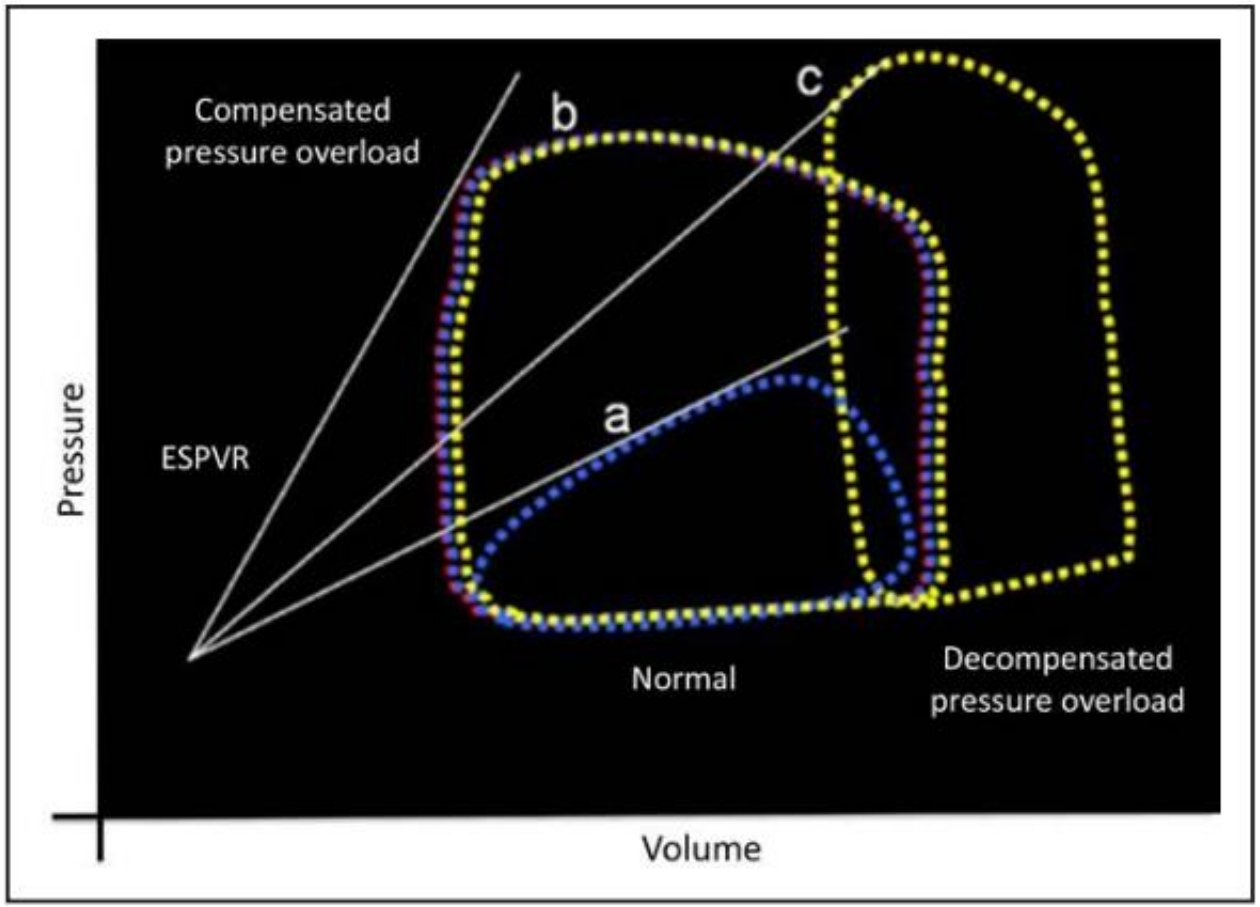
Anatomically Complex RV



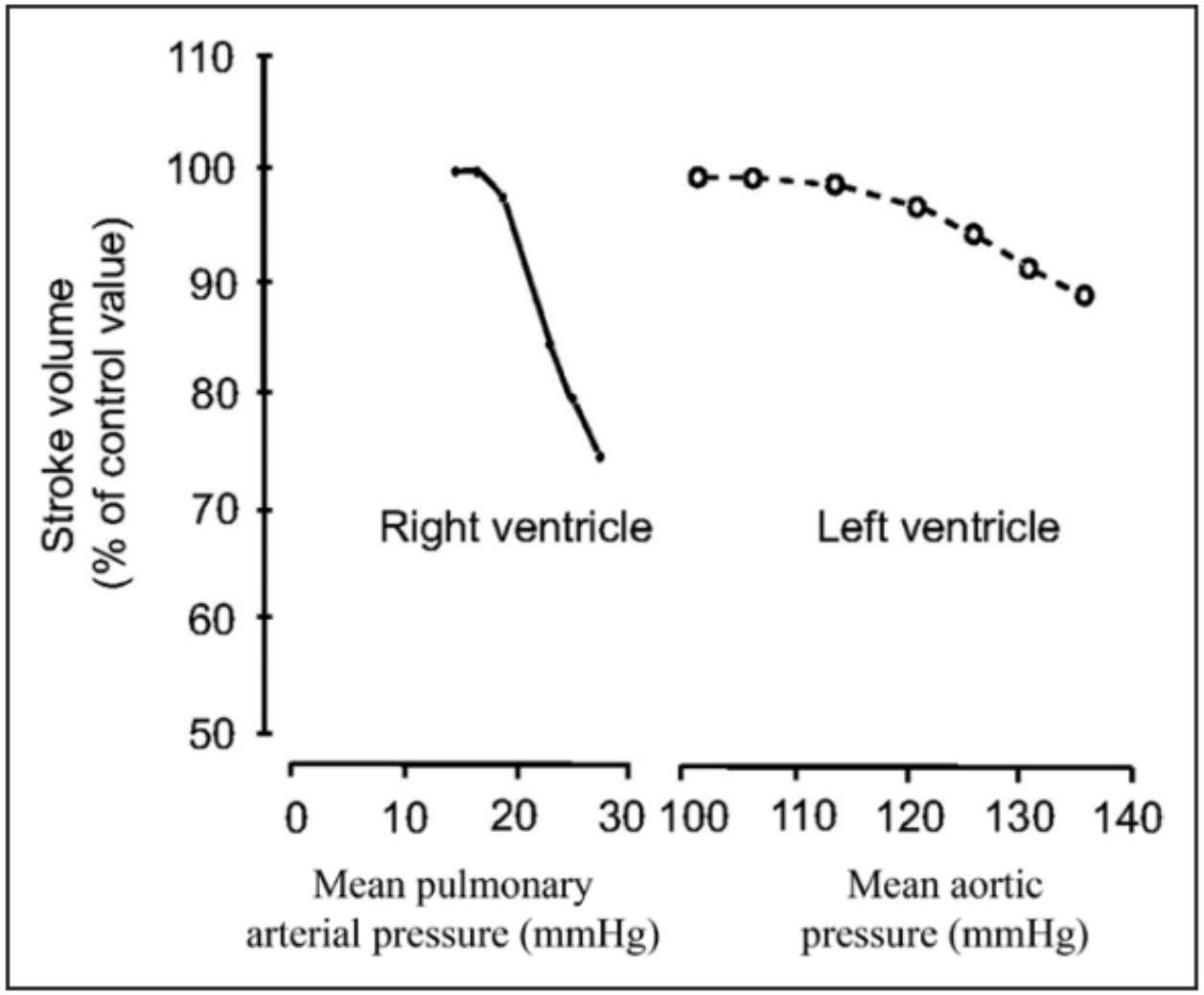
Physiology

- 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


Compensated
pressure overload
b
c
a
ESPVR
Pressure
Normal
Decompensated
pressure overload
Volume

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

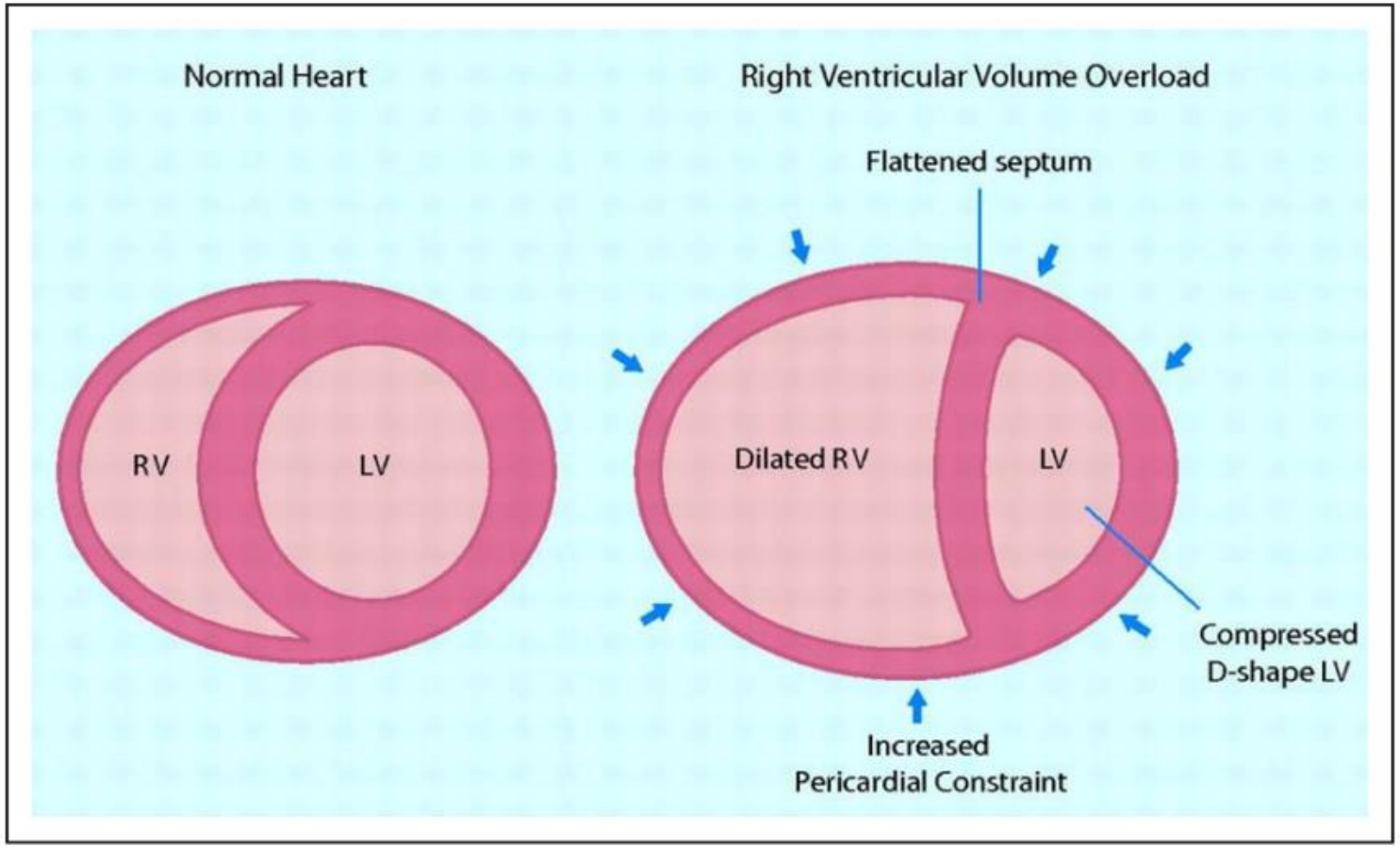
Acute RHF

- 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

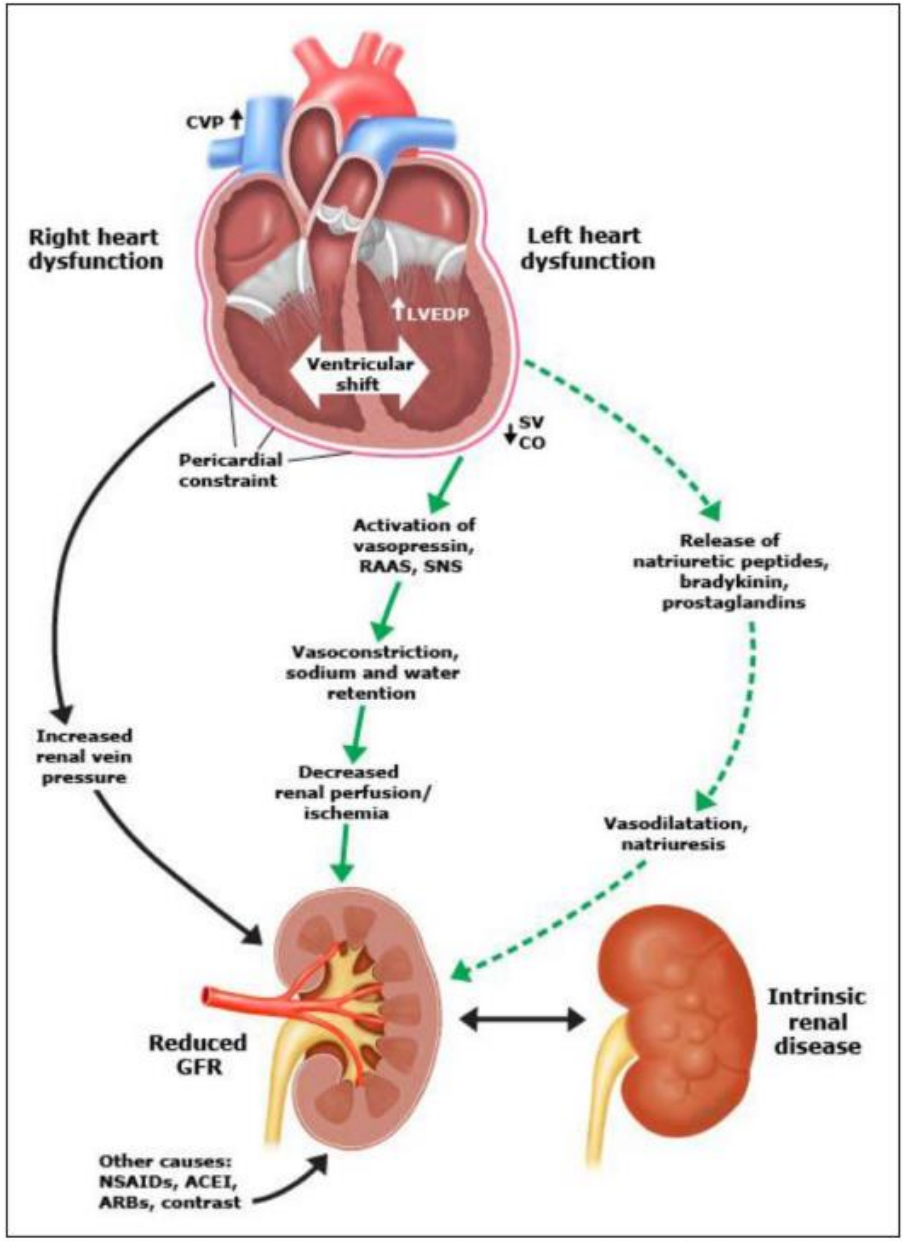


Clinical Recognition

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

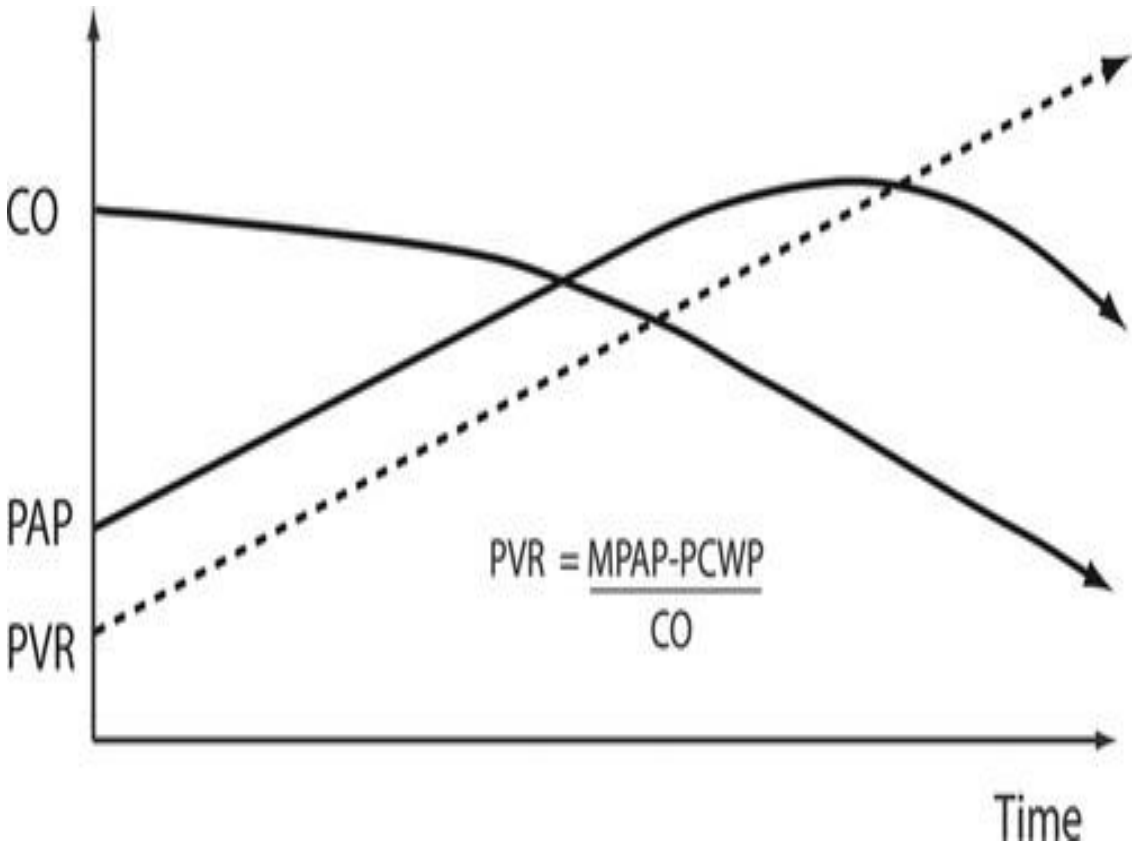
Clinical recognition

- Transaminitis
- Elevated total bilirubin
- Cardiorenal syndrome



Echocardiography

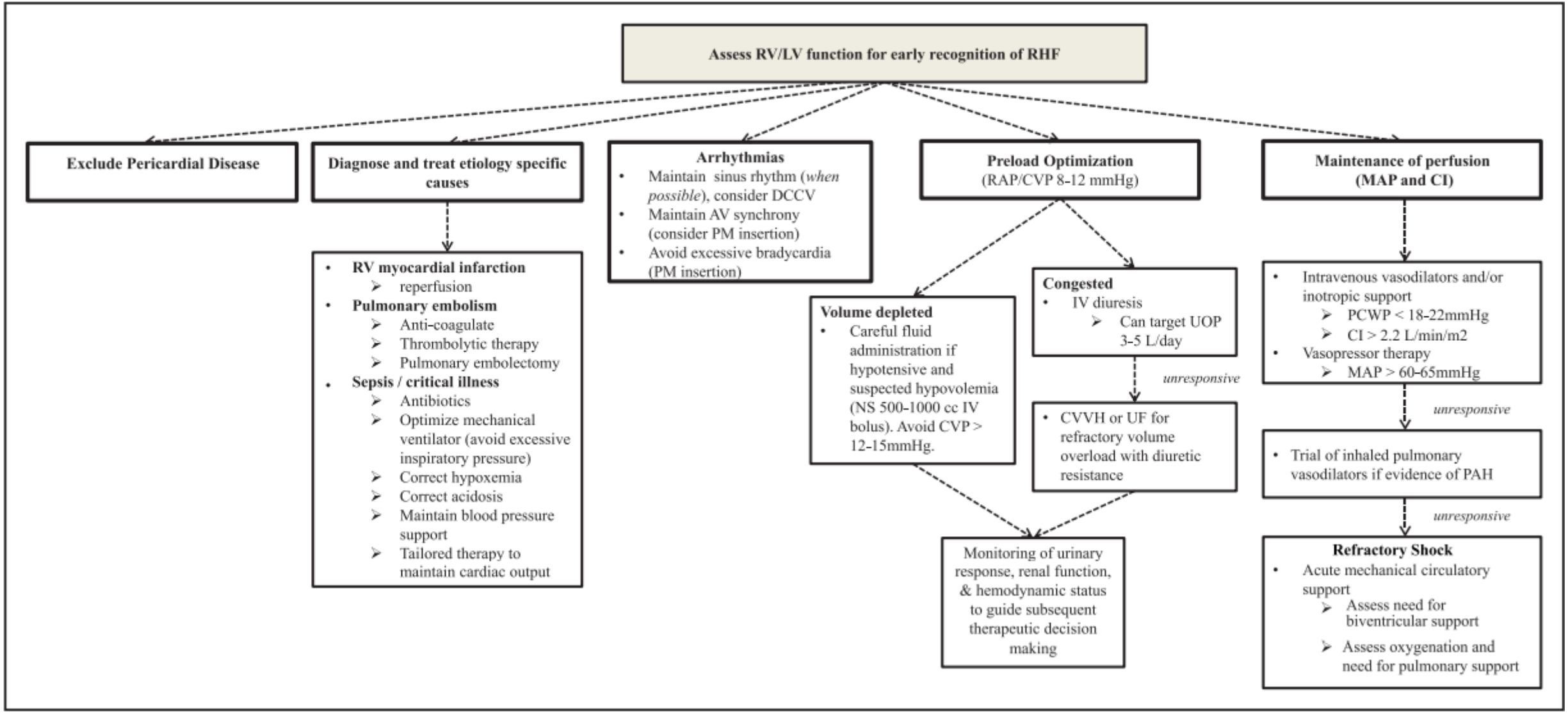
- RVEDD > 4.2
- RV area dimension > LV area dimension
- TAPSE ≥ 1.7 cm
- TDI s’ < cm/s
- In shock, don’t be fooled by low RVSP on echo
- Septal bowing leftward
- IVC measurements
- Hepatic vein flow reversal



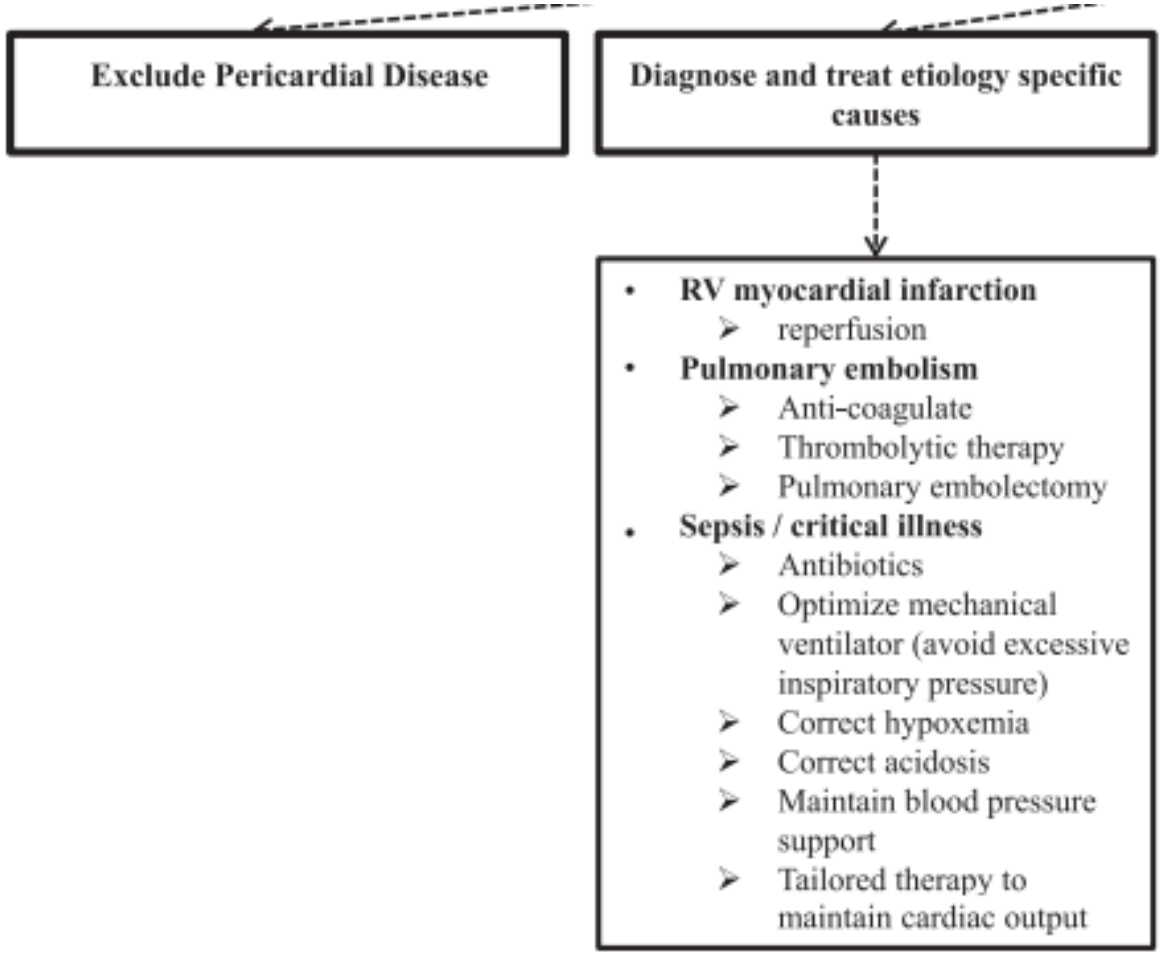
Hemodynamic Assessment

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	(PASP–PADP)/RAP	<1.0 (RHF in acute MI)[203] <1.85 (RHF after LVAD)[204]
RV stroke work index	(MPAP–CVP)×SVI	<0.25–0.30 mm Hg·L/m^2 (RHF after LVAD)[205,206]
PVR	(MPAP–PCWP)/CO	>3.6 WU (RHF after LVAD)[207]
PA compliance	SV/(PASP–PADP)	<2.5 mL/mm Hg (RHF in chronic HF, RV-PA coupling in PAH)[26,115]

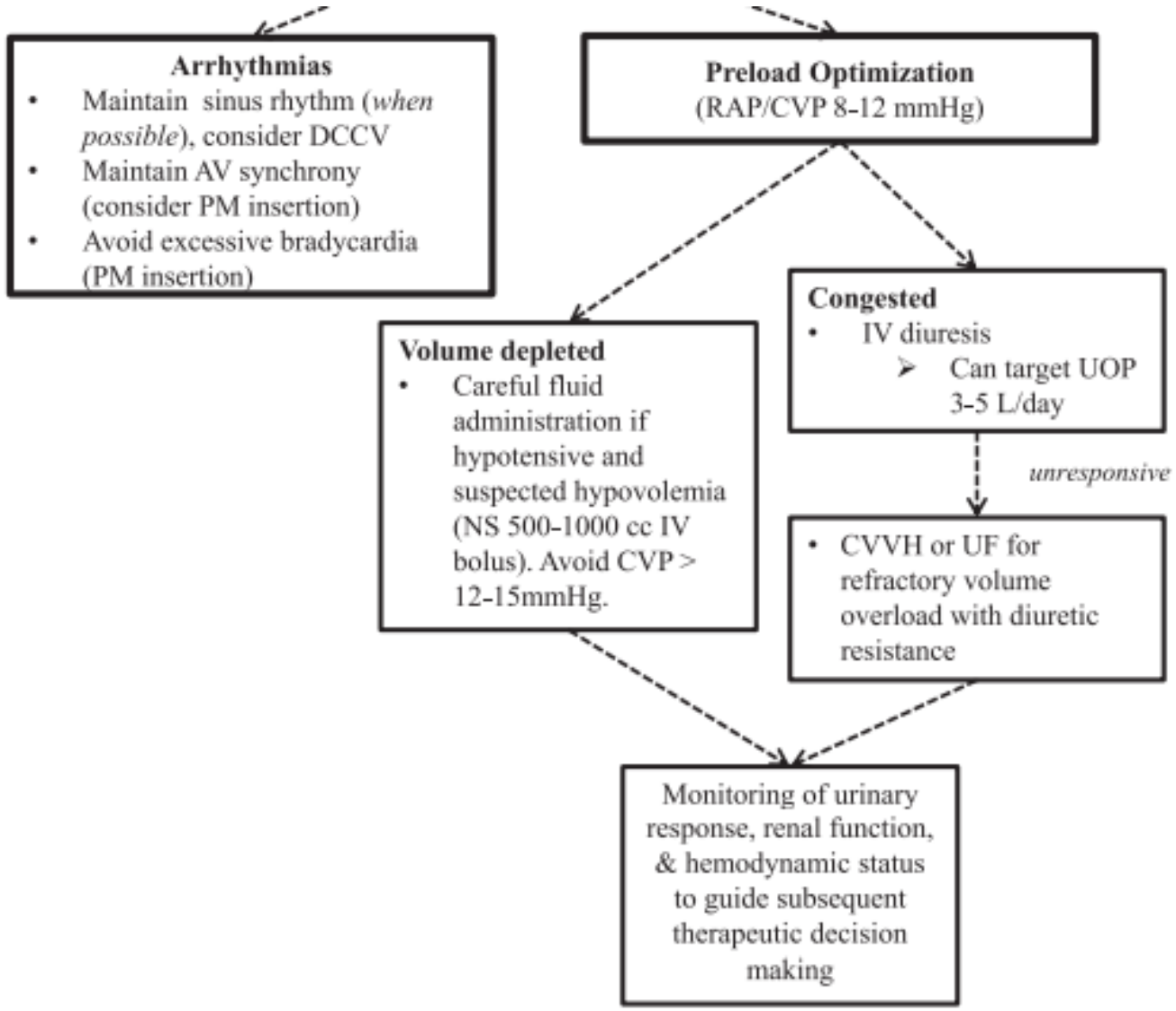
Management of Acute RHF



First, determine the etiology

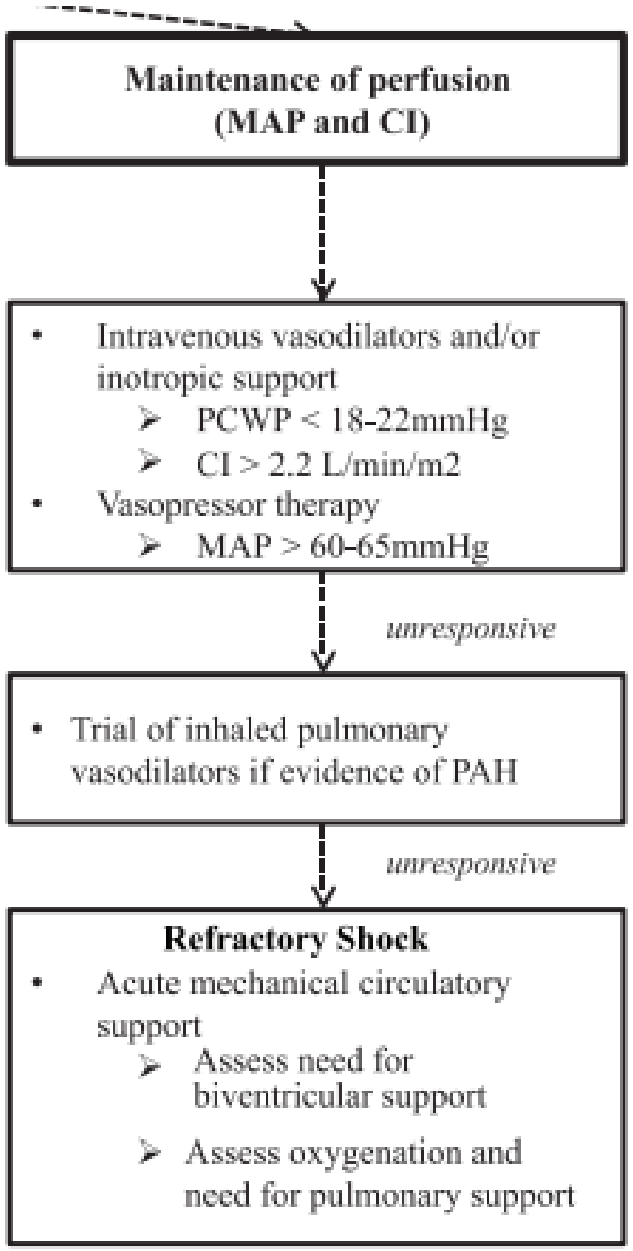


Control for arrhythmias and preload issues

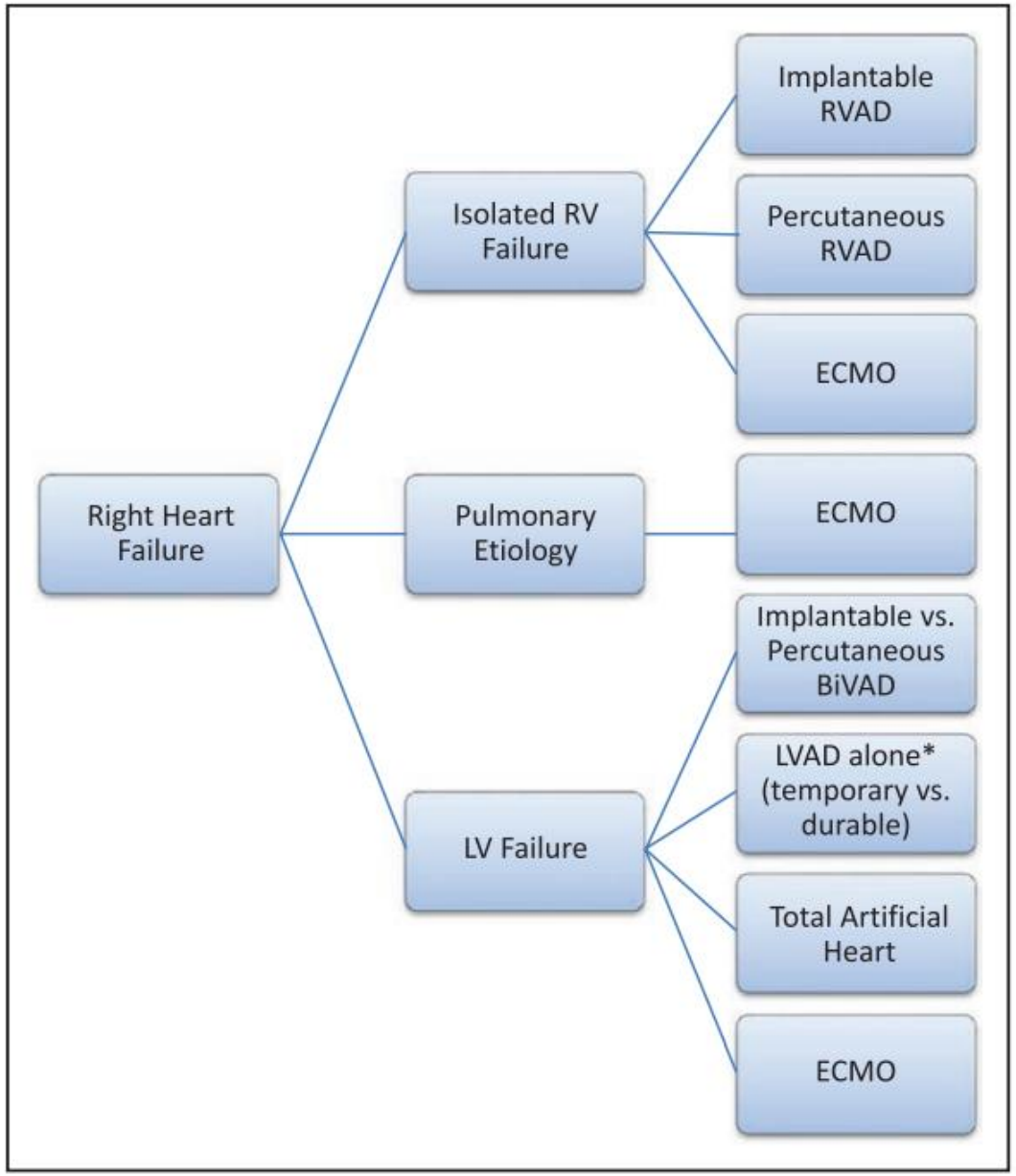


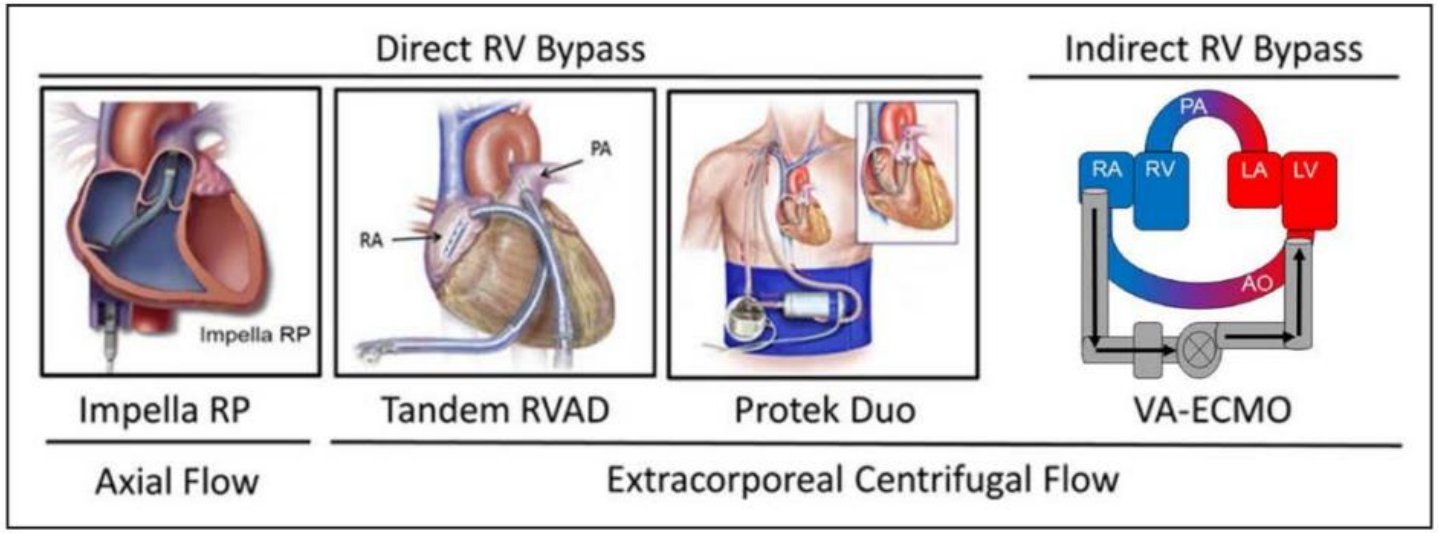
Focus on contractility and afterload

- 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