Echocardiography in the care of the pregnant patient

Amy Sarma, MD
Co-Director of the Women's Heart Health Program and Cardiovascular disease and Pregnancy Program at Massachusetts General Hospital

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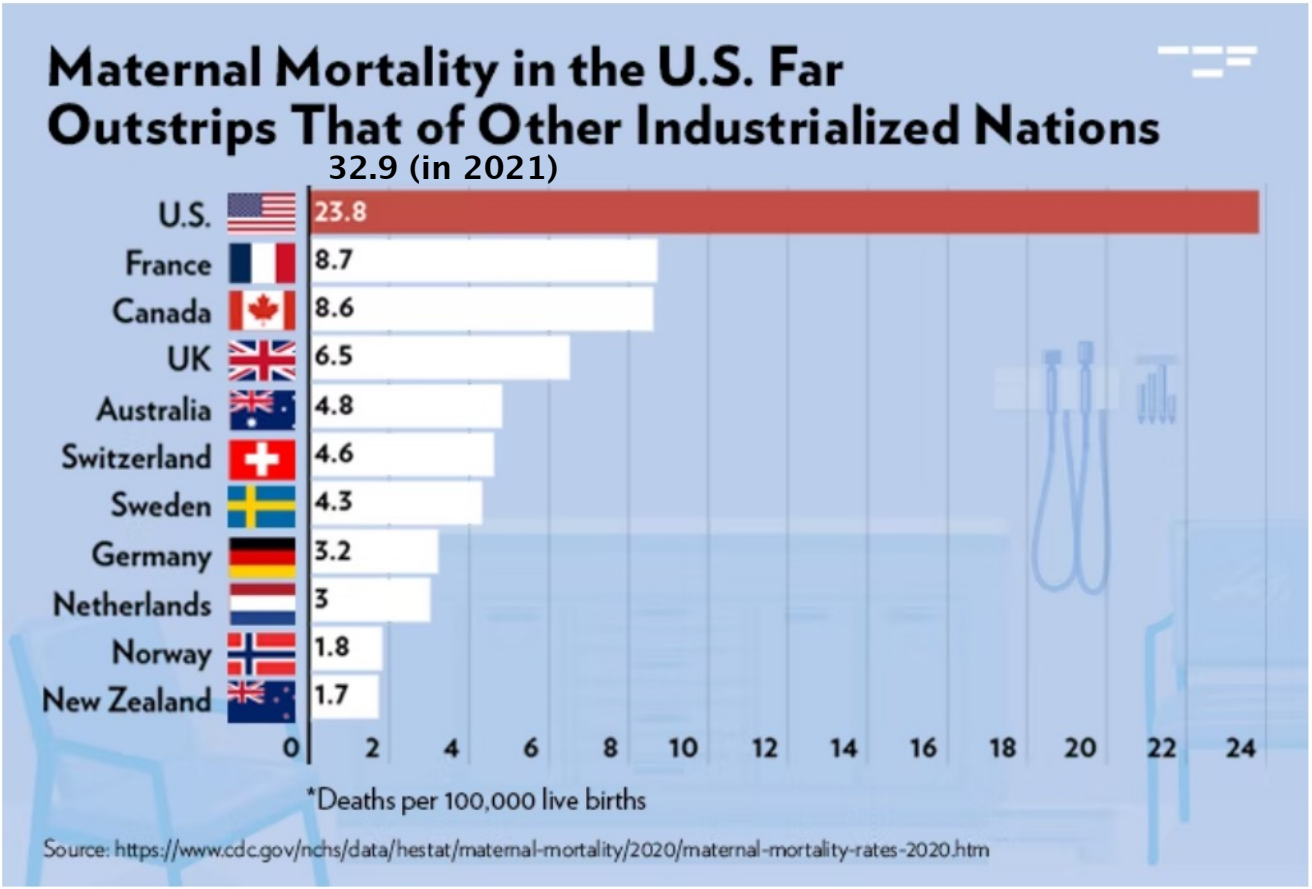
Disclosures

Funding

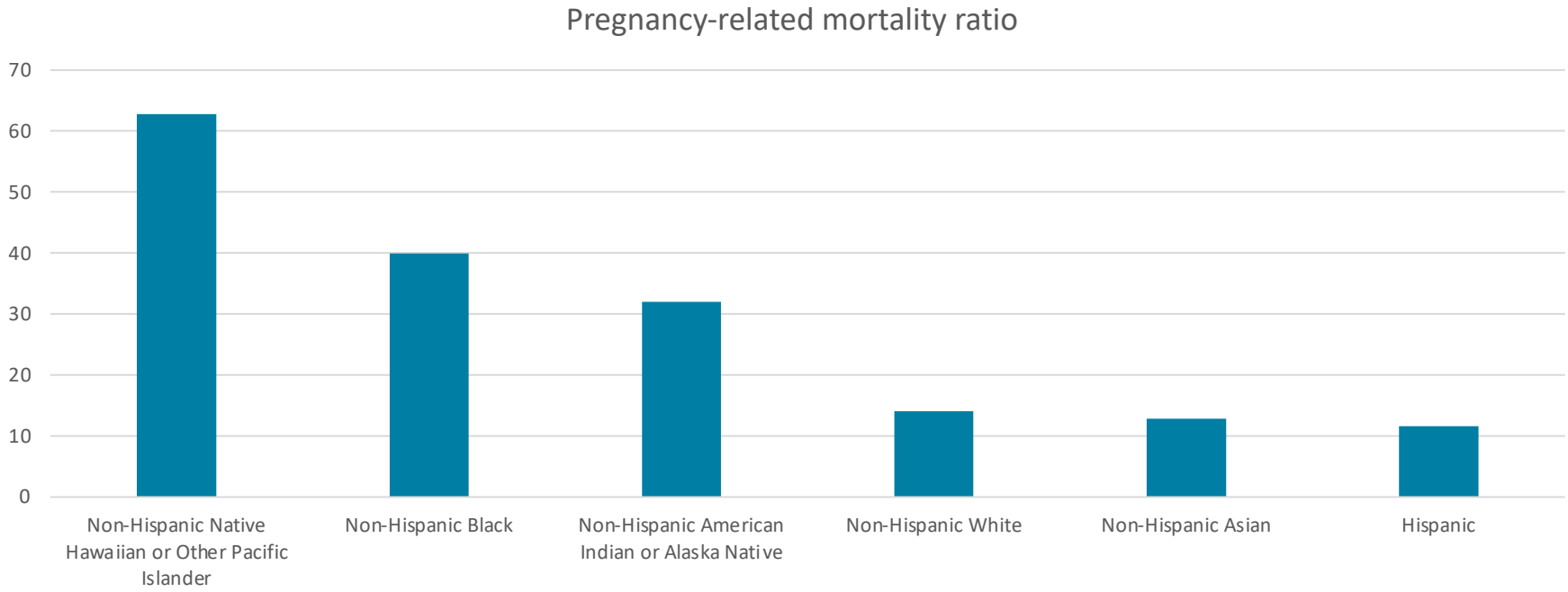
CRICO Patient Safety Grant

Why is this important?



Leading causes of maternal mortality
Cardiovascular
Pre-eclampsia/ eclampsia
Hemorrhage
Thromboembolism
Amniotic fluid embolism
Infection
Stroke

Disparities in maternal risk

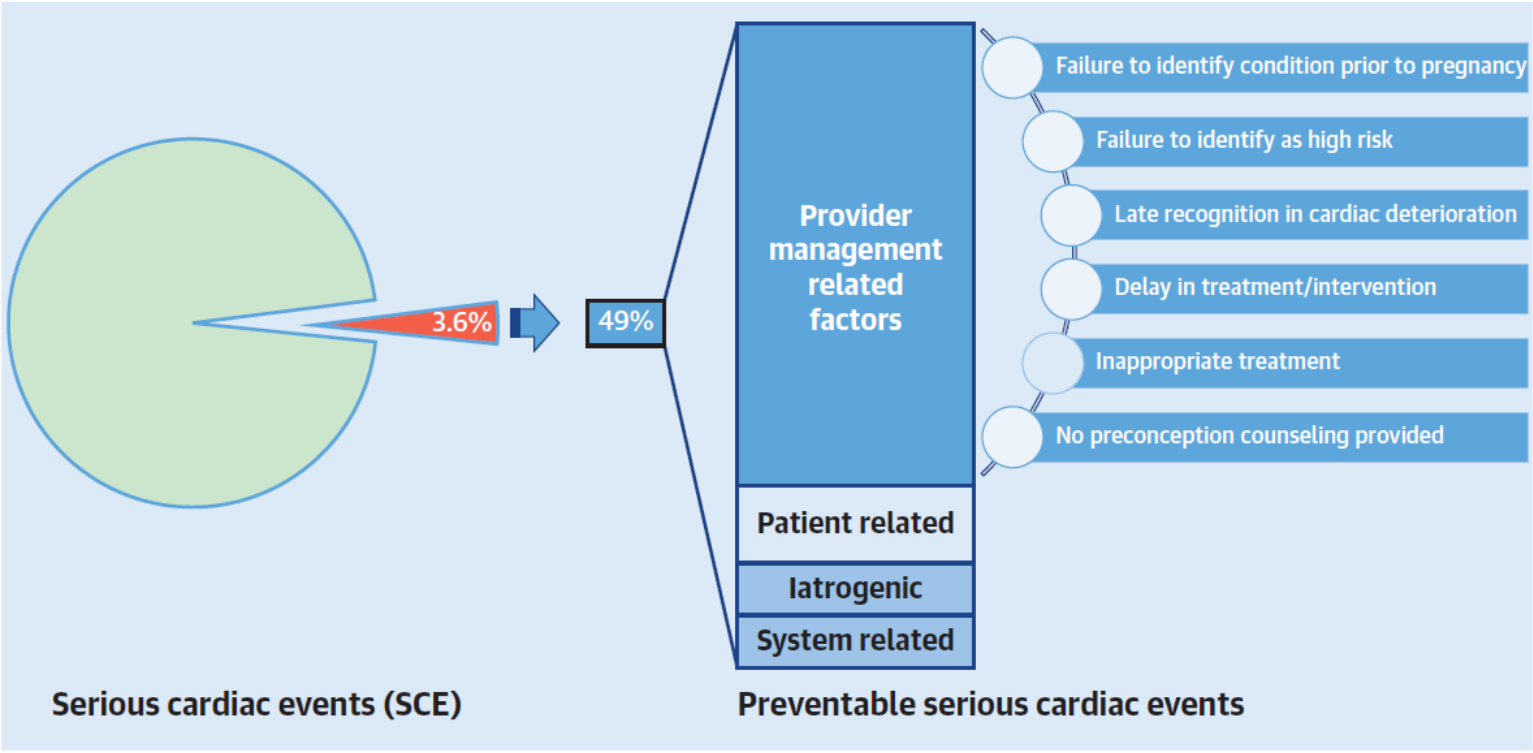


CDC Pregnancy Mortality Surveillance System

Timing of maternal mortality: Risk does not end with delivery

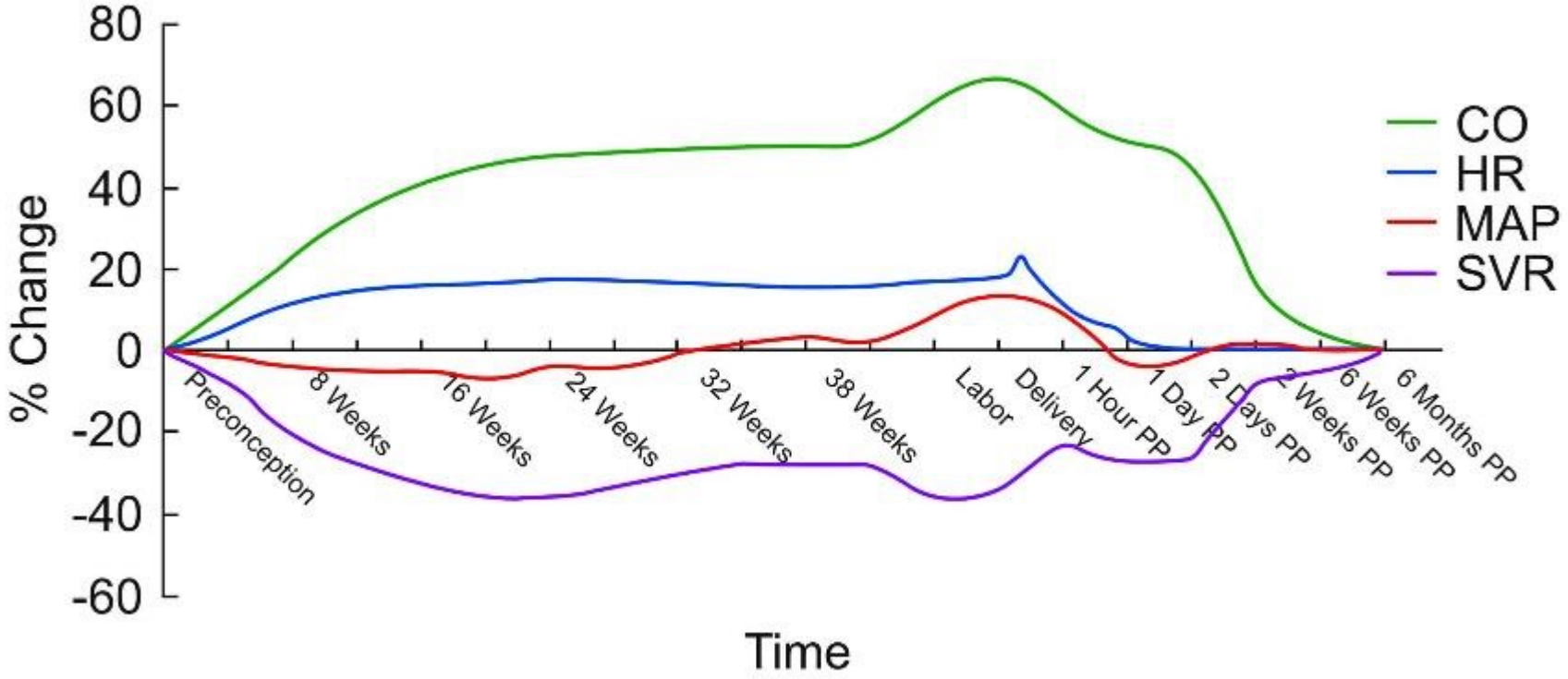
Understanding normal to recognize abnormal

CENTRAL ILLUSTRATION Preventable Serious Cardiac Events in Women With Heart Disease and Their Contributing Factors



Pfaller, B. et al. J Am Coll Cardiol. 2020;75(12):1443-52.

Pregnancy as a Cardiovascular Stress Test



Halpern, Sarma et al. Hurst's the heart 4th edition.

Case

- 32 W, G5P4 who presented at 37 weeks of gestation with tachycardia, dyspnea, and weakness
- Prior pregnancies were uncomplicated
- HR 150's, BP 97/79, requiring 2L supplemental O2

Canobbio et al. AHA scientific statement.

Table 5. Clinical Signs and Symptoms Observed in Normal Pregnancy

Hyperventilation causing shortness of breath and dyspnea
Brisk, full carotid upstroke with distended jugular veins with prominent A and V waves
Diffuse, displaced left ventricular impulse; palpable RV impulse
Increased first heart sound; persistent splitting of second heart sound
Systolic ejection-type murmurs at the left lower sternal border over the pulmonary area
Anemia
Weight gain

- Chest pain
- Dyspnea at rest
- Paroxysmal nocturnal dyspnea
- Syncope
- Sustained palpitations
- Symptoms starting and progressively worsening >20 weeks gestation

- Diastolic murmur
- Heart rate >100 bpm
- Cyanosis or clubbing
- Rales
- S4 or Gallop

FIGURE 3 Concerning Signs and Symptoms of CVD in Pregnancy. *Image courtesy of Niti R. Aggarwal.*

Advantages to echocardiography

- Widely available
- Cost effective
- No radiation
- No known adverse effects of diagnostic ultrasound

Regitz-Zagrosek et al. Eur Heart J. 2018

TTE considerations

- General imaging protocols are similar to non-pregnant patients
  - Limitations to subcostal imaging in late pregnancy
- Due to compression of the IVC and pelvic veins (particularly > 20 weeks gestation), left lateral decubitus positioning is preferred
  - Cardiac output is 14% lower supine
  - 8% of women will experience supine hypotension
- No rigorous studies but agitated saline contrast is used when required at our institution
- Generally avoid echocardiographic contrast agents
  - Lack of data

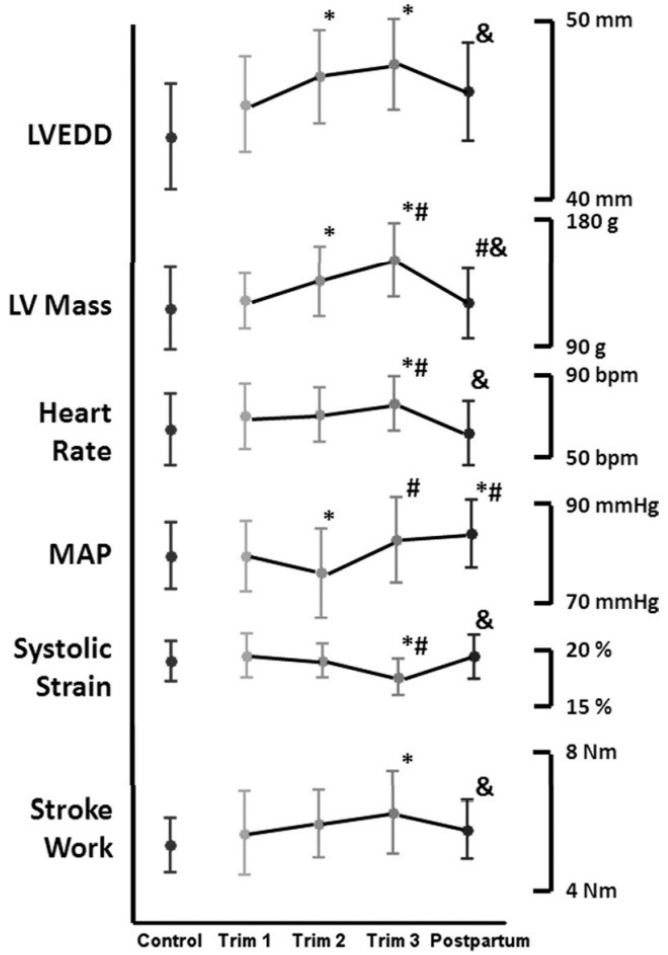
Canobbio et al. Circ. 2017, ACOG Guidelines for Diagnostic Imaging during pregnancy and lactation 2017, Muskula & Main. Circ Cardiovasc Imaging. 2017

Normal maternal echocardiographic changes

Unchanged	Increased	Normal findings
Ejection fraction	LV chamber dimensions	Pericardial effusion (often trace to mild)
Fractional shortening	RV chamber dimensions (RV diastolic area)	Pseudodyskinesis
Peak myocardial systolic velocity	Biatrial size	
E/E’	LV mass (eccentric hypertrophy)	
RVSP	Valvular annular dimensions	
	Cardiac output	
	Aortic and pulmonic VTI	
	Valvular regurgitation (except aortic)	

Adapted from Afari, Davis, Sarma. Curr Treat Options Cardiovasc Med. 2021

Strain imaging in normal pregnancy



For LV:
*p<0.05 vs trim 1
# p<0.05 vs trim 2
& p<0.05 vs

Savu et al. Circ Imaging. 201

When should you consider echocardiography?

- Preconception among patients with preexisting CVD
- Role in preconception counseling
  - Cardiomyopathy
  - Valvular heart disease
    - Prosthetic valves
  - Congenital heart disease
  - Aortic dilation
  - Pulmonary hypertension
  - Oncologic treatment: ≥300 mg/m2 cumulative anthracycline, ≥30 Gy chest radiation, combination chemotherapy and radiation, known arrhythmias or structural sequelae*

*Children's Oncology Group Recommendations

Intervals for routine re-imaging among patients with CVD

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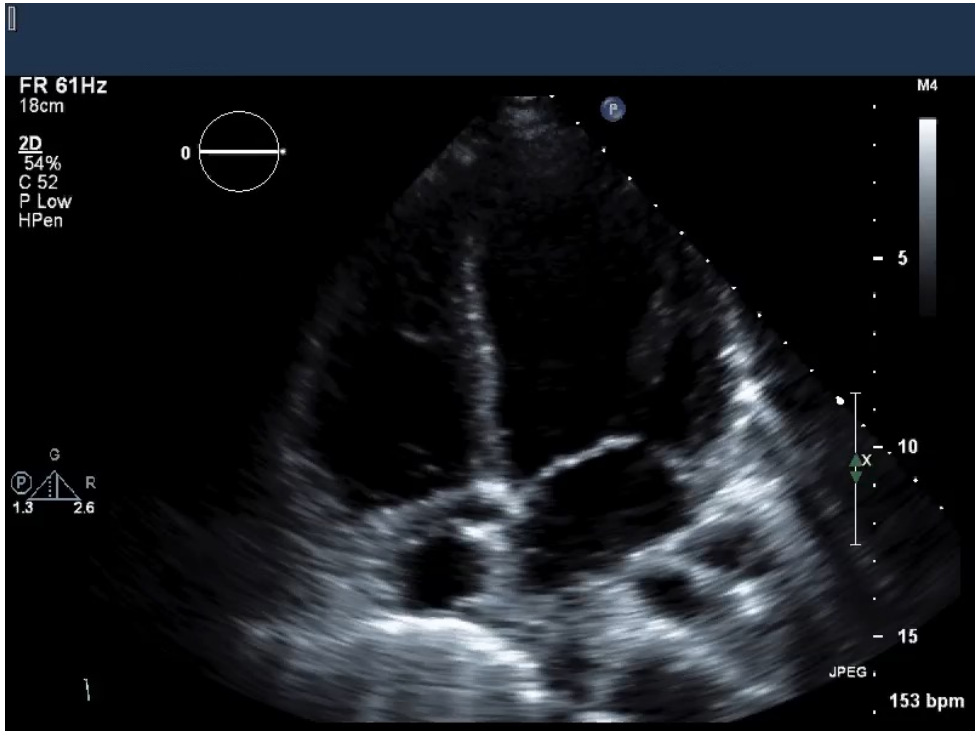
- Standard intervals for routine reimaging are lacking
- Consider each trimester except if guided by clinical changes
- Data from the STORCC initiative*
  - 12% of patients have significant echocardiographic changes found on routine monitoring (preconception, 2nd trimester, 3rd trimester, postpartum)
  - 24% resulted in management decisions
  - Further study is needed
  - Acquired conditions account for an increasing proportion of disease and complications

Regitz-Zagrosek et al. Eur Heart J 2018; *Valente et al. Am Heart J 2019

Back to our patient

- NTproBNP 57K, standard trop T 3.78, Cr 0.79



Peripartum cardiomyopathy

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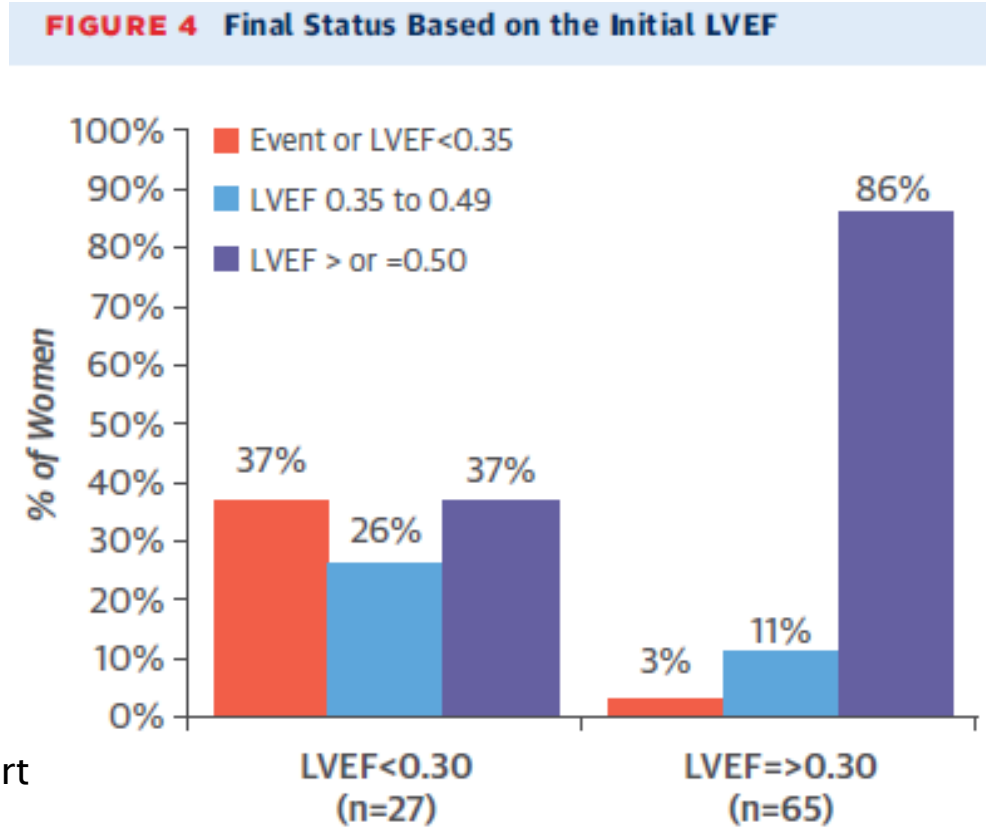
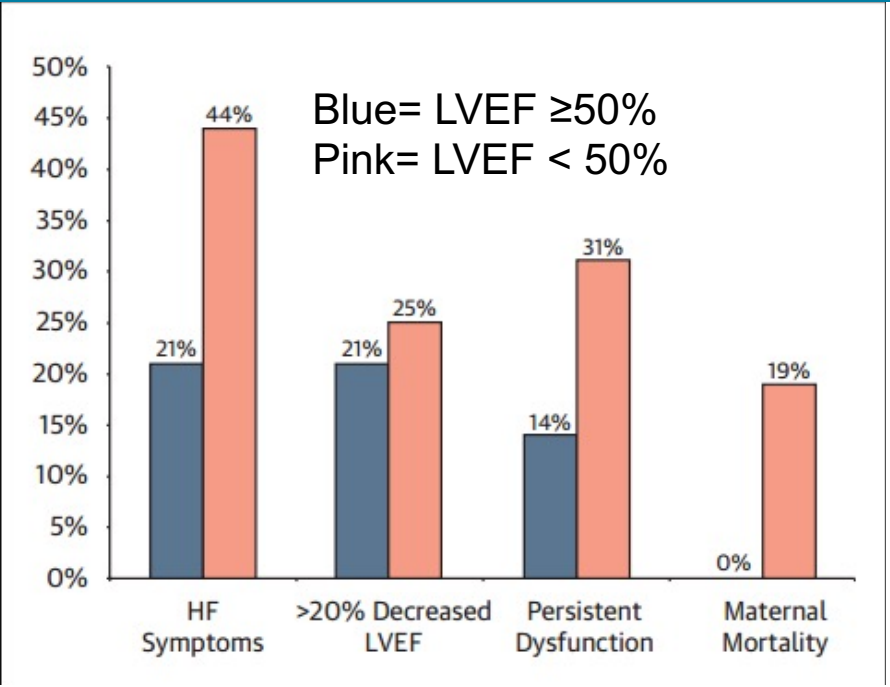
- LV <45% towards the end of pregnancy or in the months following delivery where no other cause is found
- IPAC study: Baseline LVEF and LVEDD aid in prediction of recovery
  - RV FAC
  - GLS > -10.6 (additive predictive value to LVEF)
  - Image for LV thrombus

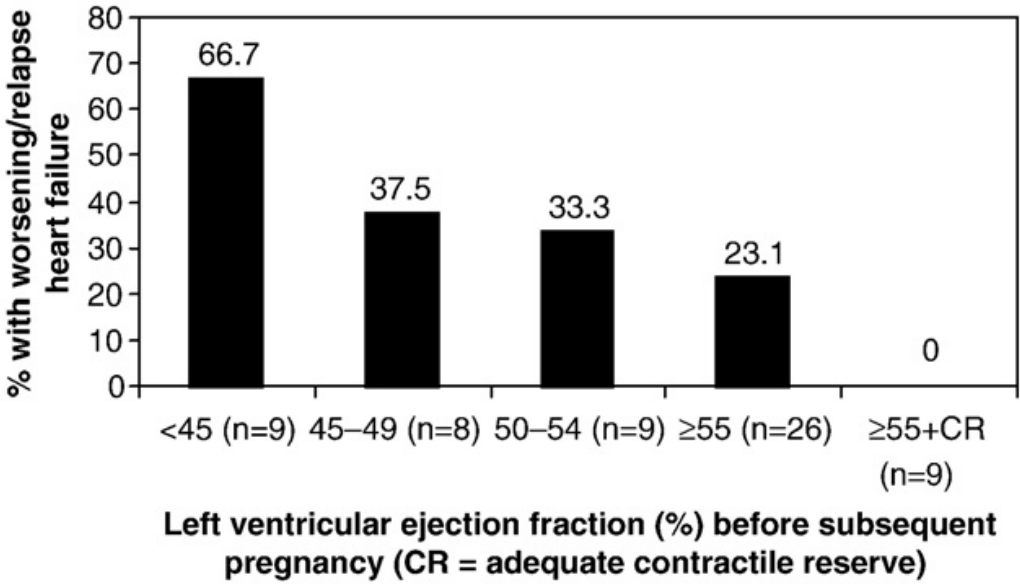


McNamara et al. JACC 2015; Blauwet et al. Circ Heart Fail 2016; Sugahara et al. JASE 2019

Peripartum cardiopathy



Resting TTE preconception



Stress echo for contractile reserve

Elkayam et al, JACC; Fette et al, 2010

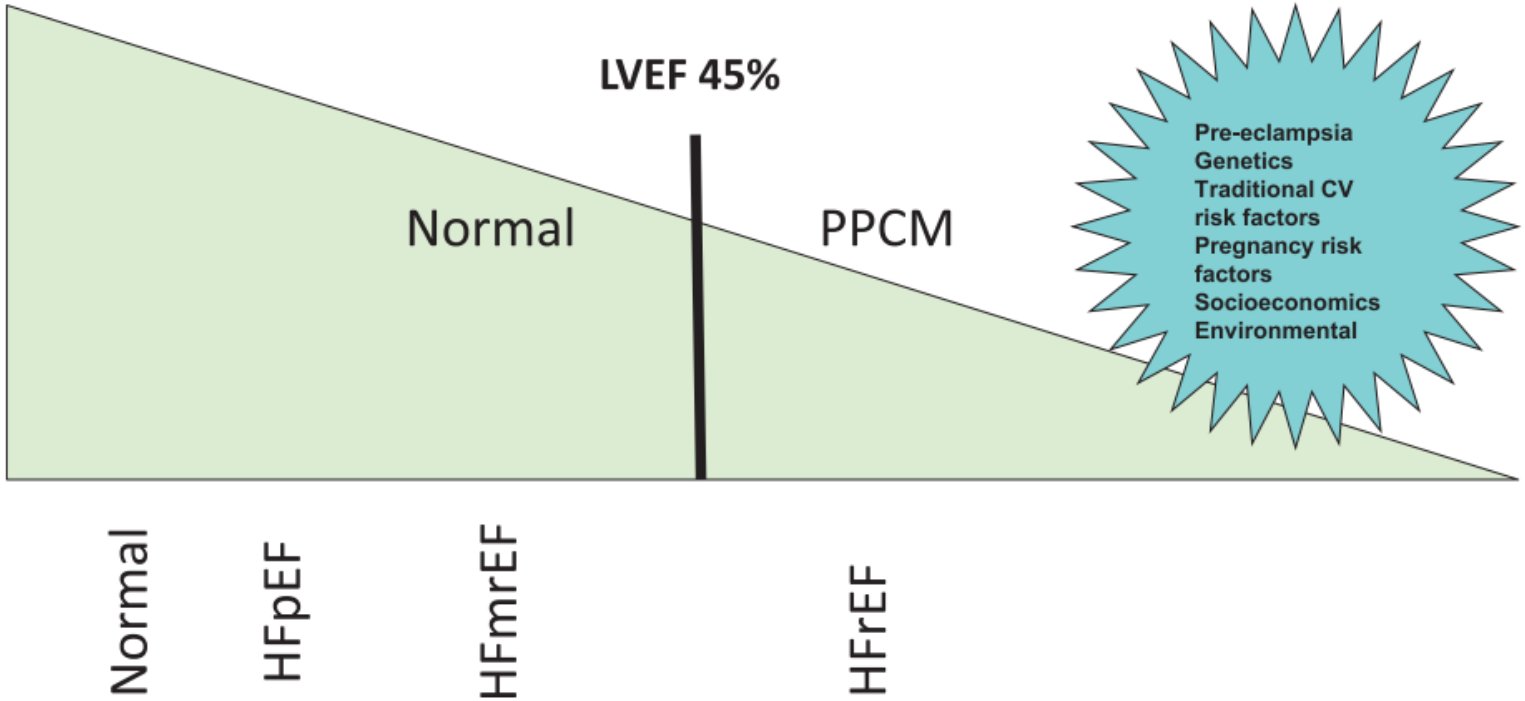
TEE

- Can be performed during pregnancy
  - E.g. TEE/ DCCV
- Increased risk of aspiration
  - Decreased gastric motility (progesterone)
  - Increased relaxation of the lower esophageal sphincter
  - Increased intra-abdominal pressure from the gravid uterus

  - Involve cardiac anesthesia
  - Consider endotracheal intubation for TEE after first trimester

Bello et al, JACC 2021

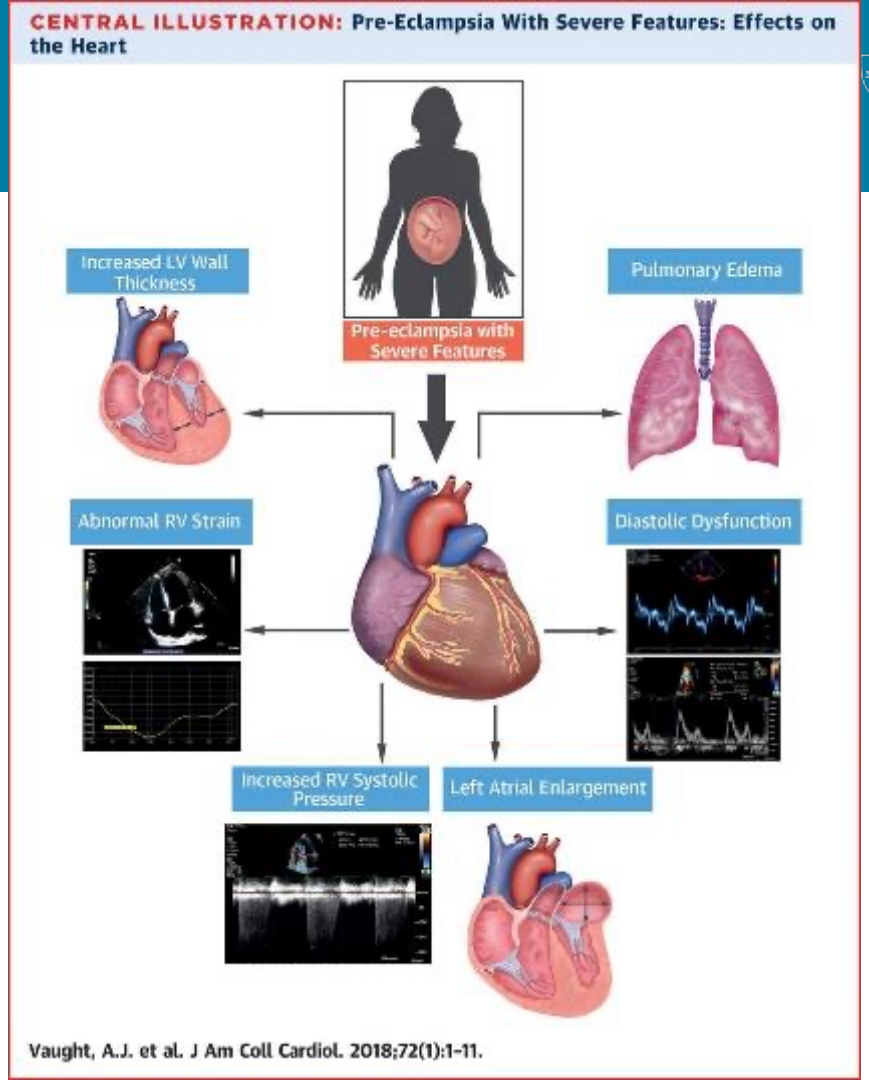
Spectrum of pregnancy-associated heart failure



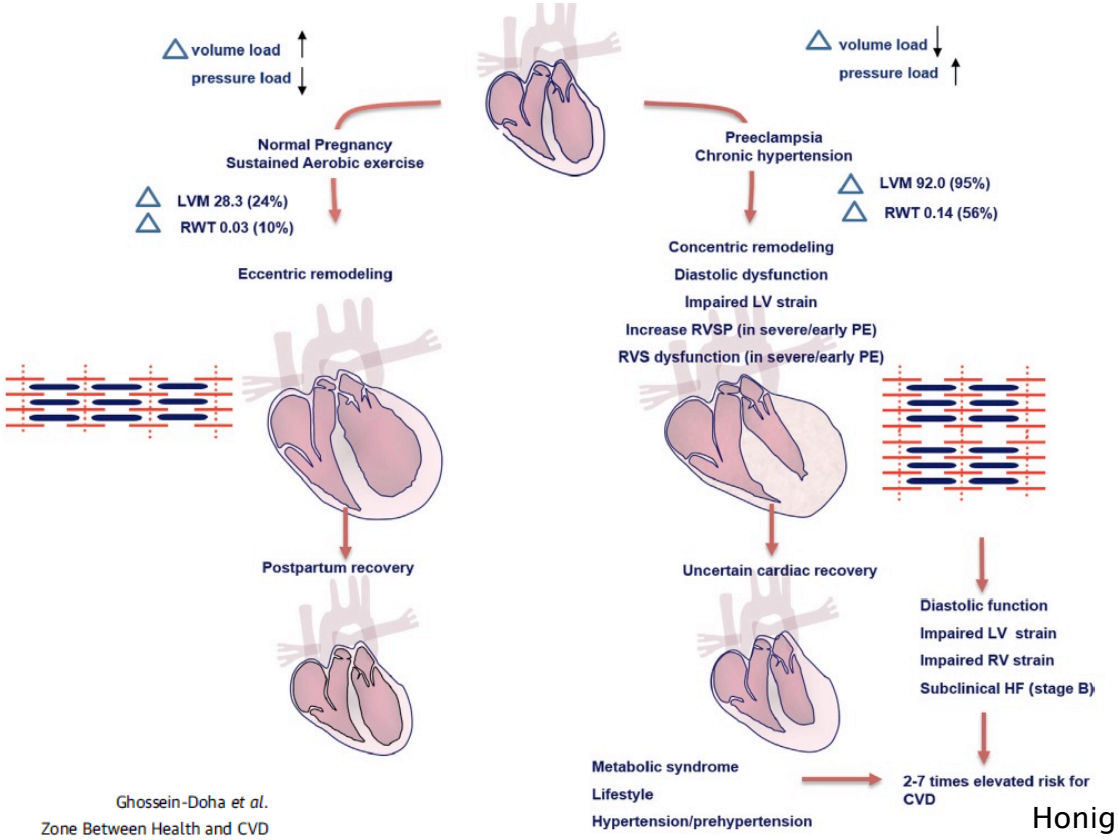
Lindley KJ. J Cardiac Failure. 2021

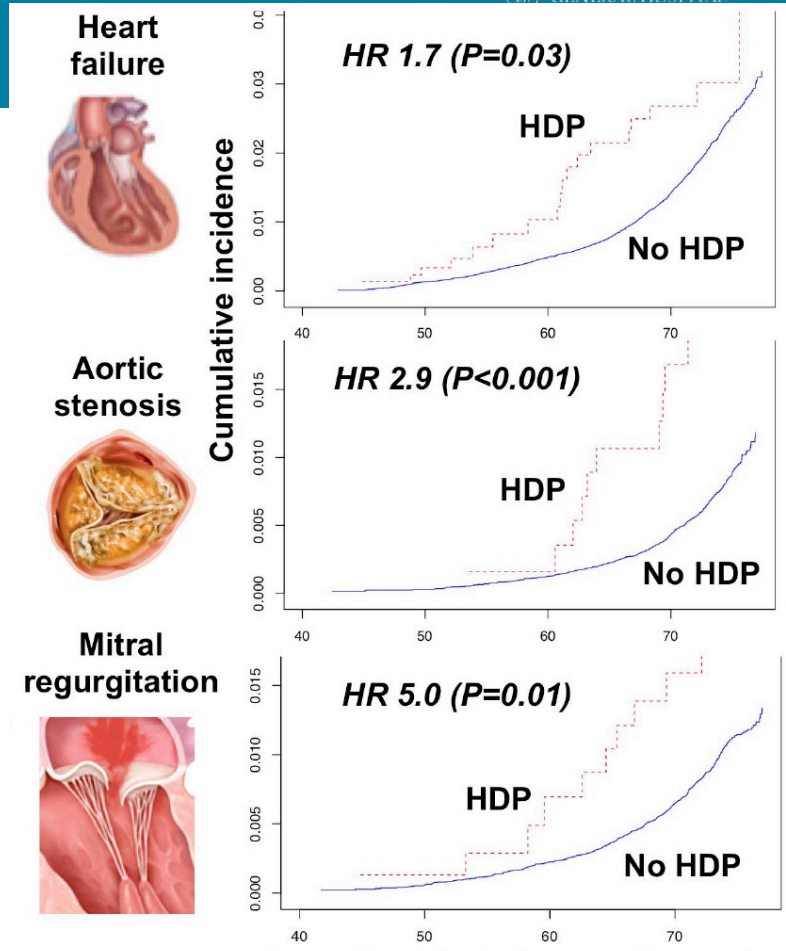
Acute preeclampsia

- Concentric vs eccentric remodeling
- Absolute changes are modest



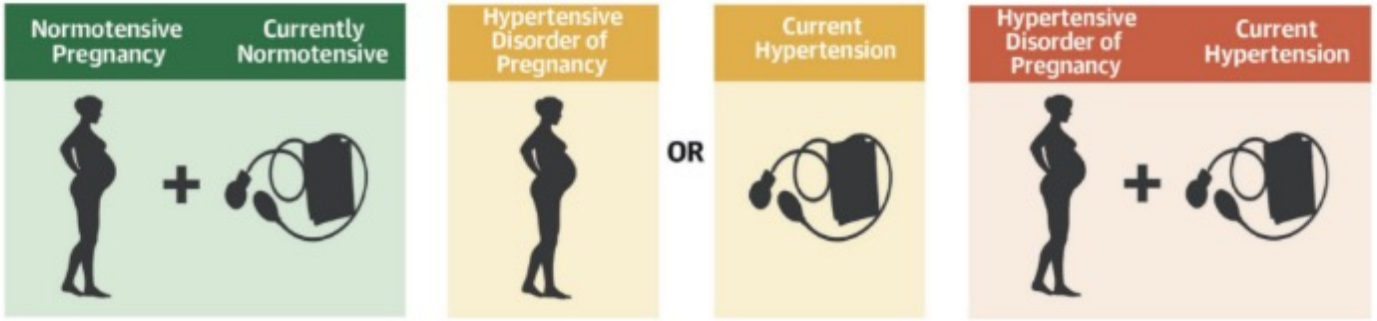
Long-term changes

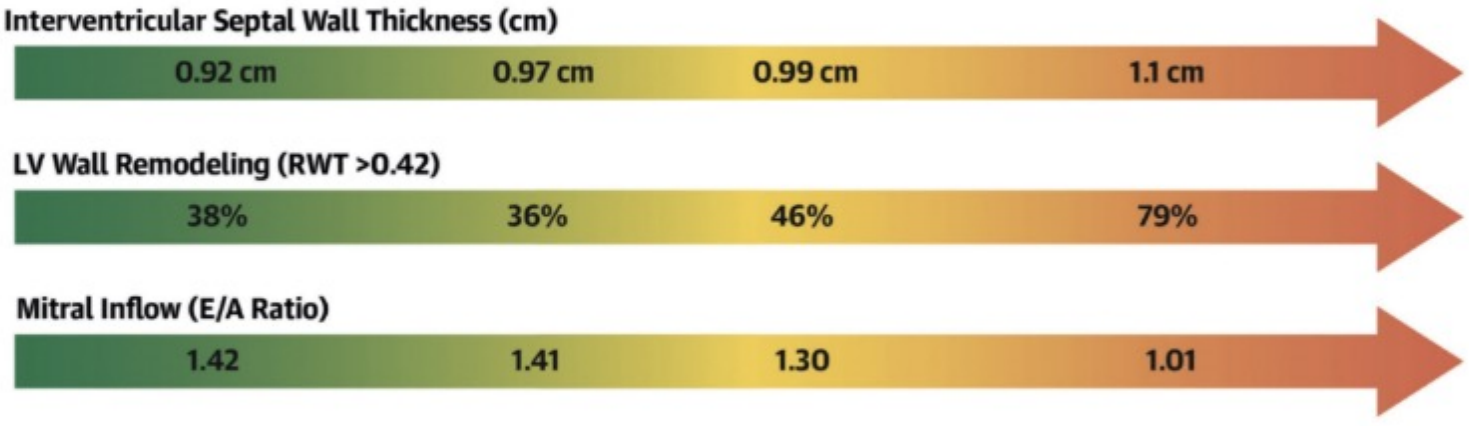




Honigberg et al, JACC 2019

Long-term changes: Preeclampsia





Countouris, M.E. et al. J Am Coll Cardiol. 2021;77(8):1057-68.

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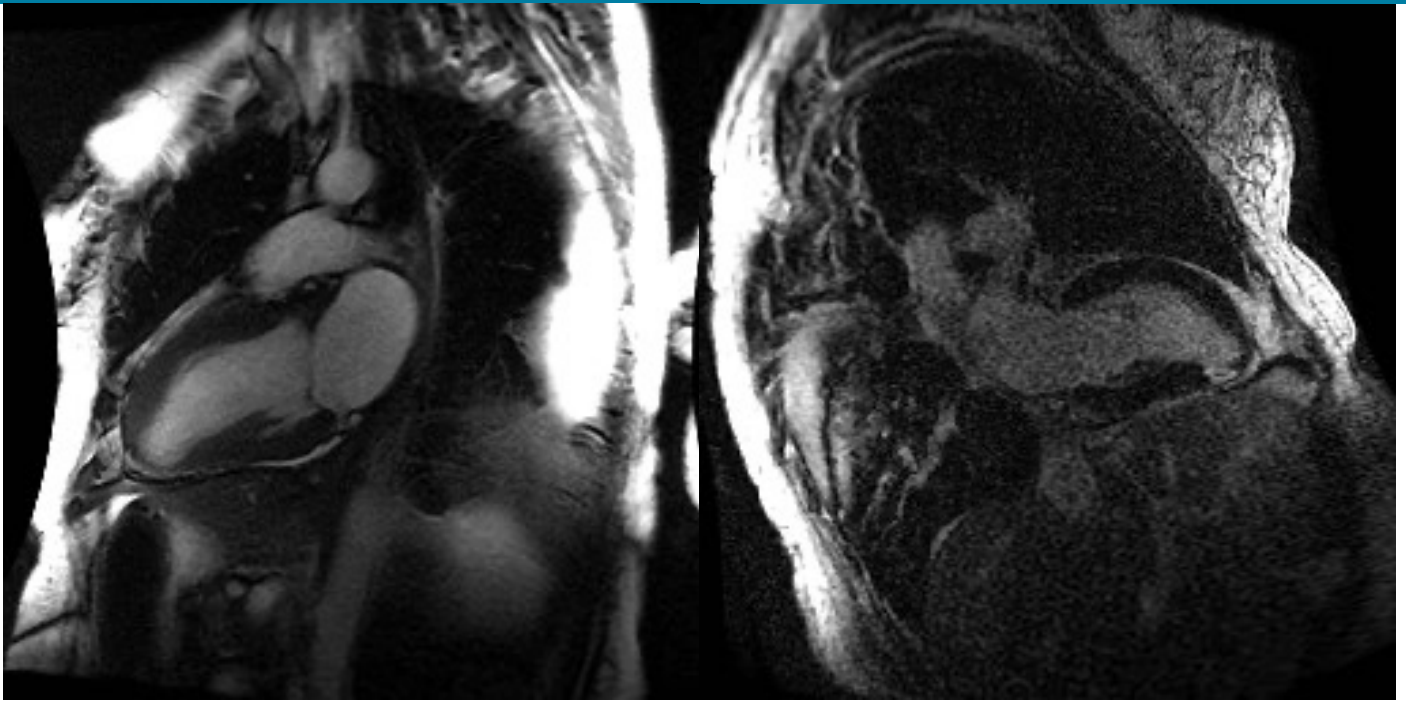

- Small near-transmural ischemic infarct in the apical inferior LV
- Minimal apical laminar thrombus
- Mildly dilated LV with LVEF 49%

- CMR remains a preferred modality during pregnancy to avoid radiation exposure
- Avoid gadolinium (image obtained postpartum)

Imaging for suspected ischemic disease

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Evaluation	Management	Coronary Angiography
Symptom assessment ECG Echocardiography	Antiplatelet therapy - aspirin Anticoagulation (IV heparin) Beta-blockers and nitrates - avoid hypotension Interdisciplinary discussion between cardiology, interventional cardiology & MFM	Careful injection during coronary angiography due to concern for SCAD
Pregnancy-associated MI most commonly occurs postpartum Two-thirds of pregnancy-related MI events are anterior in location, and 42% are STEMI	**Low risk with non-ST segment MI** - Consideration of coronary angiography, but medical management may be considered **High risk** - (hemodynamic instability/arrhythmia/active symptoms) - proceed with coronary angiography	Radiation management: Radial access, ALARA principle, collimation, reduced fluoroscopy frame rate, avoid cineangiography in favor of "fluoro-save" feature

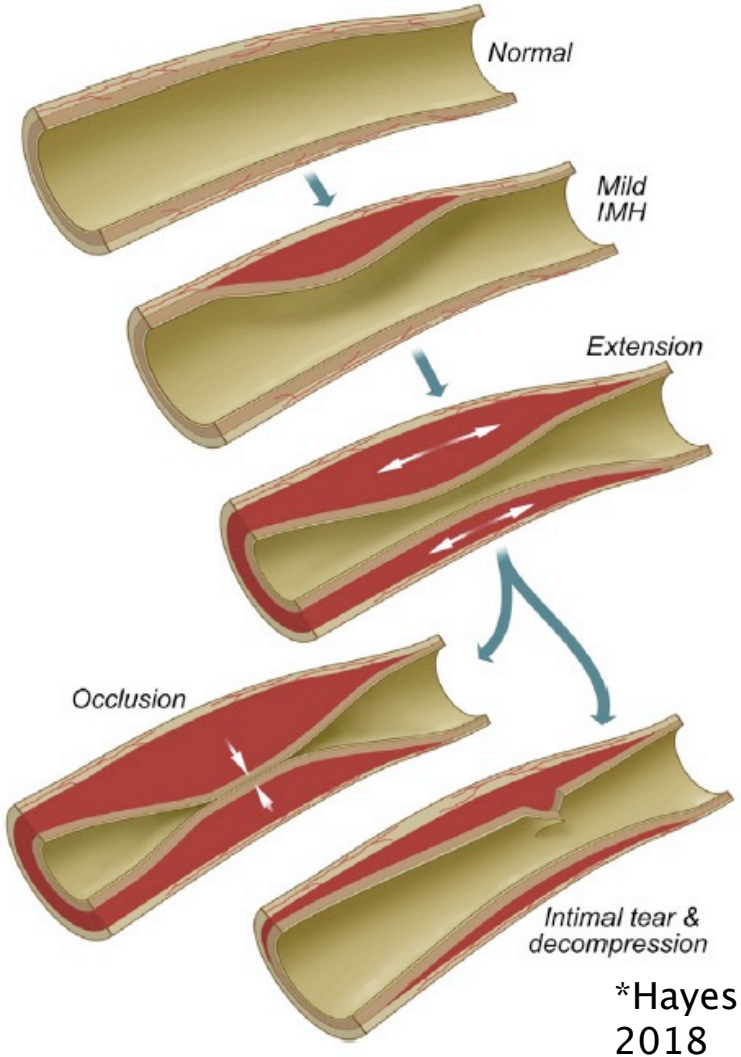
- Cath remains gold standard
- Can consider coronary CT
- TTE for wall motion

Park et al. JACC. 2021

"SCAD is defined as an epicardial coronary artery dissection that is not associated with atherosclerosis or trauma and not iatrogenic"*

Differences as compared with atherosclerotic coronary disease:

1. Pathophysiology: medial dissection and not plaque rupture/erosion
2. PCI is challenging and conservative therapy is often favored
3. Majority of SCAD heals with medical therapy



*Hayes Circulation 2018

CENTRAL ILLUSTRATION: Features of Pregnancy-Associated Spontaneous Coronary Artery Dissection

Spontaneous Coronary Artery Dissection (SCAD)

A coronary artery hematoma ± tear limits coronary blood flow to the myocardium

Hematoma

Tear in arterial wall

Pregnancy-associated SCAD (P-SCAD)

- **Frequently occurs in first month postpartum** (majority of these within first week after delivery)
- **P-SCAD presentation often severe:**
  - ST-segment elevation myocardial infarction
  - Reduced left ventricular function
  - Left main and/or multivessel SCAD
- **Compared to non-pregnancy-associated SCAD:**
  - P-SCAD has a higher risk presentation
  - P-SCAD patients are older at time of first childbirth and more frequently have history of multiple pregnancies
  - P-SCAD patients have fewer extracoronary vascular abnormalities

Recommended areas of P-SCAD research:

- Hemodynamic stressors
- Hormonal fluctuations
- Oxytocin release in breastfeeding mothers
- Older, multiparous mothers
- Relationship to:
  - Eclampsia/ pre-eclampsia
  - Peripartum cardiomyopathy
  - Fibromuscular dysplasia and other extracoronary vascular abnormalities

Tweet, M.S. et al. J Am Coll Cardiol. 2017;70(4):426-35.

Stress testing

- In pregnancy, exercise stress testing can be safely performed
  - Consider submaximal testing- minimum of 4 minutes
  - No normative values to identify a dysfunctional response
  - Consider supine bike
- Pharmacologic stress is rarely indicated: avoid pharmacologic stress agents if possible
- Preconception:
  - Consider among women with preexisting CVD: e.g. valvular heart disease

TABLE 1 Contraindications to Submaximal Exercise Stress Testing in Pregnant Women

Absolute contraindications
Persistent vaginal bleeding, especially in the second and third trimesters
Incompetent cervix, history of cerclage placement
Known hemodynamically significant cardiovascular disease
Multiple gestation
Placenta previa after 26 weeks
Pre-eclampsia/gestational hypertension
Preterm labor
Premature rupture of membranes/amniotic fluid leakage
Restrictive lung disease
Relative contraindications
Severe anemia
Bronchitis
Poorly controlled diabetes or hypertension
Dyspnea before exertion
Dizziness/presyncope

Regitz-Zagrosek et al. Eur Heart J. 2018, Bello et al. JACC 20

Echocardiography conclusions

- Widely available, safe
- Understand normative changes
- Use preconception for women with CVD
  - Interval imaging during pregnancy combined with clinical assessment
- Use when there is a cardiovascular clinical concern among any pregnant or postpartum woman

Thank you

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- Asarma1@partners.org