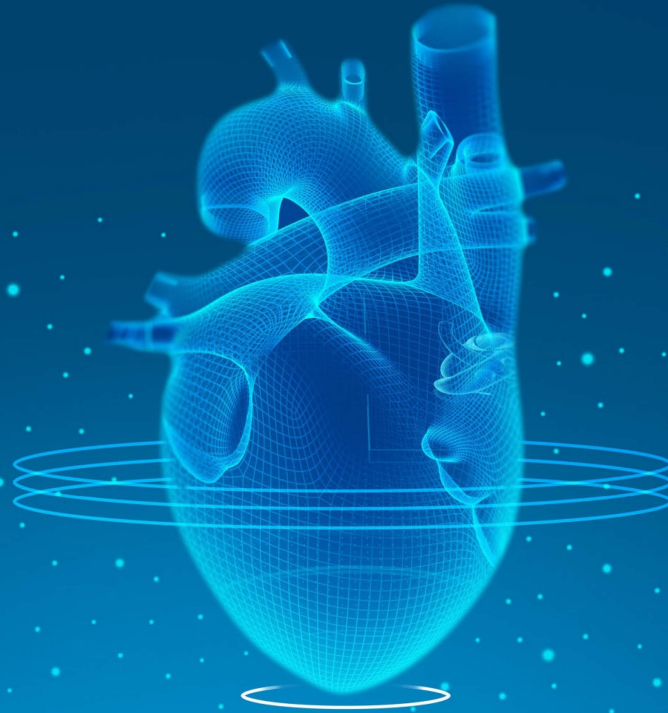




# GRAND ROUNDS



# Cardio Obstetrics: A Niche In Women's Cardiovascular Health

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March 7, 2022



WOMEN'S: Penny Anderson Women's Cardiovascular Center



@retu\_saxena

#CardioObstetrics



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## Objectives

- The scope of the problem
  - Where are we now
- Solutions
- What are we doing at Allina Health?
- Future of CVOB



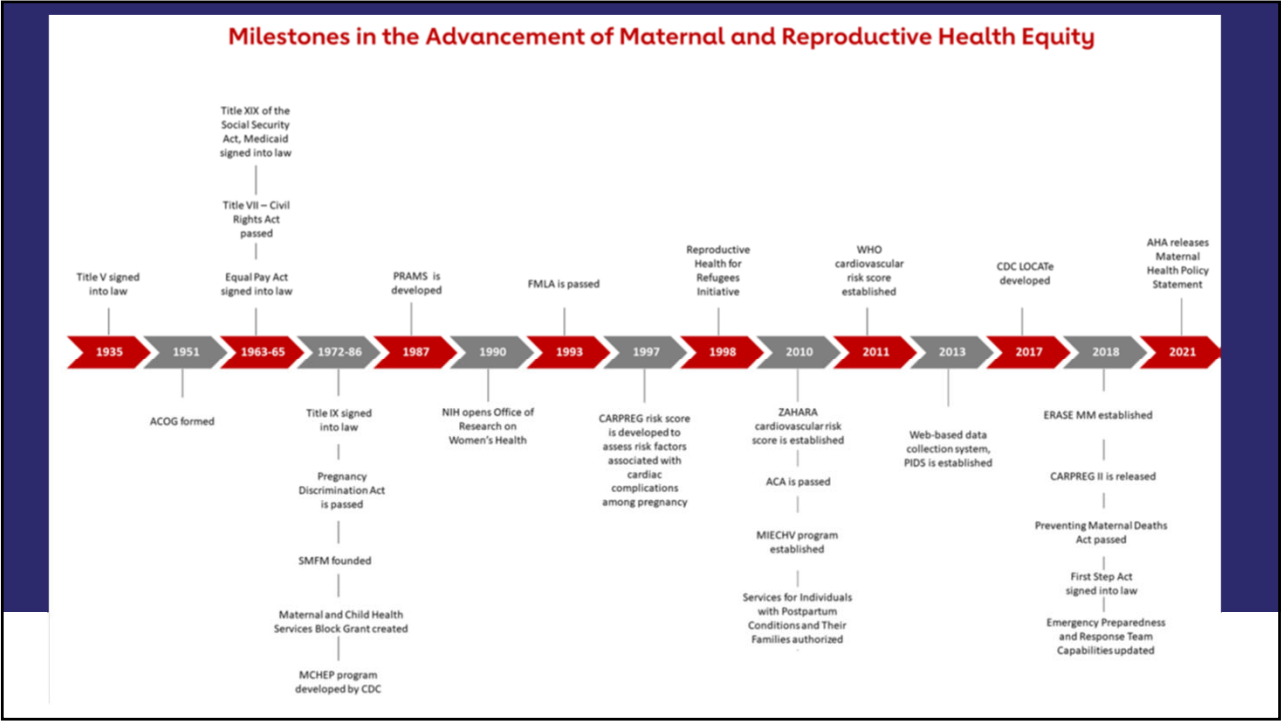
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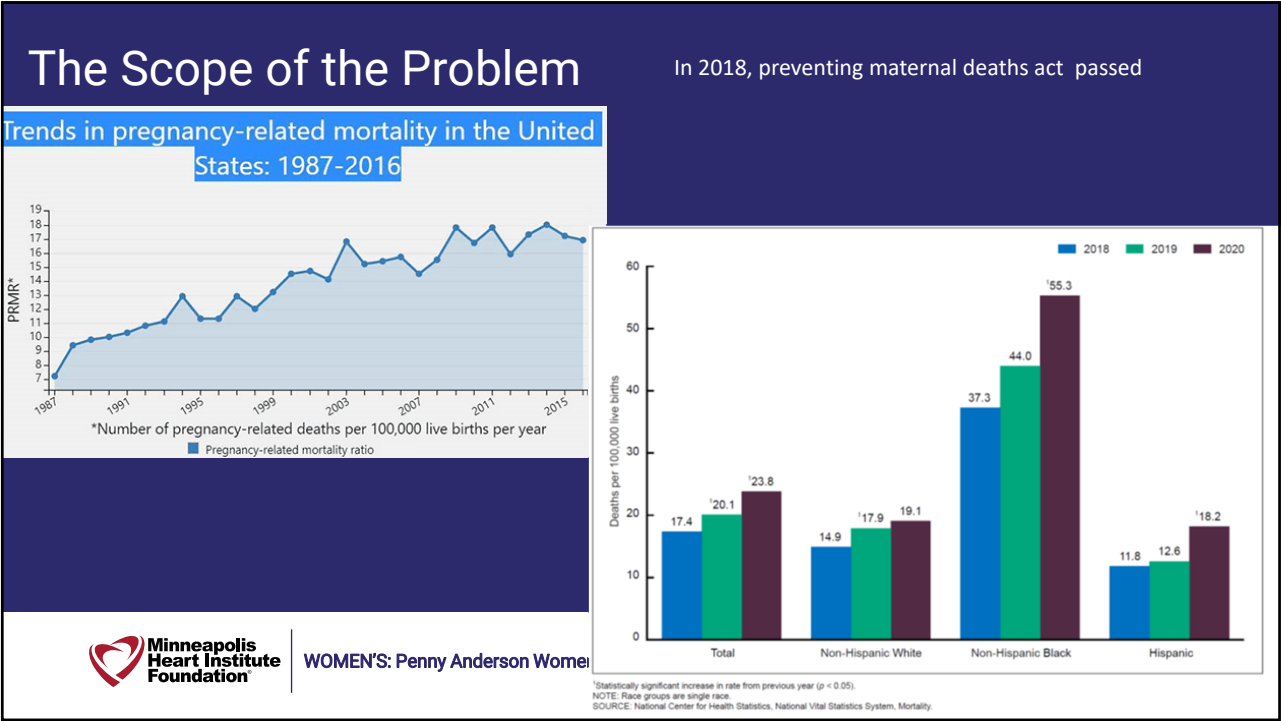
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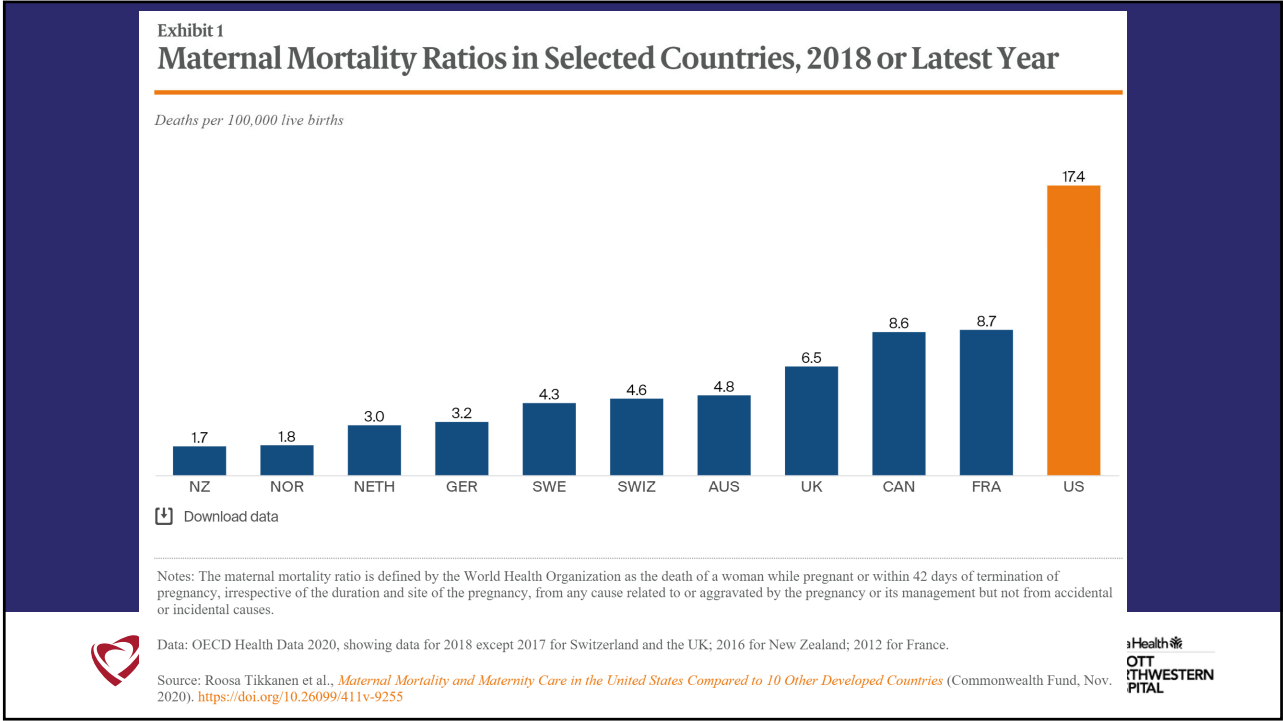
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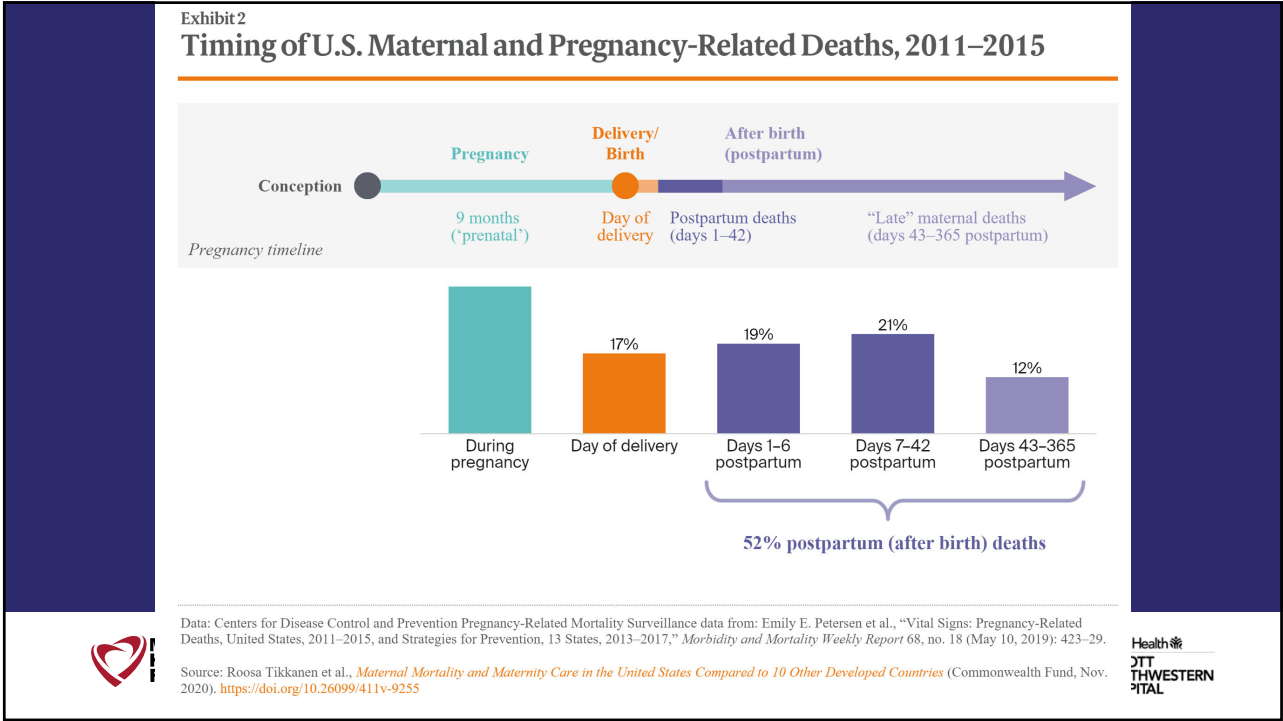
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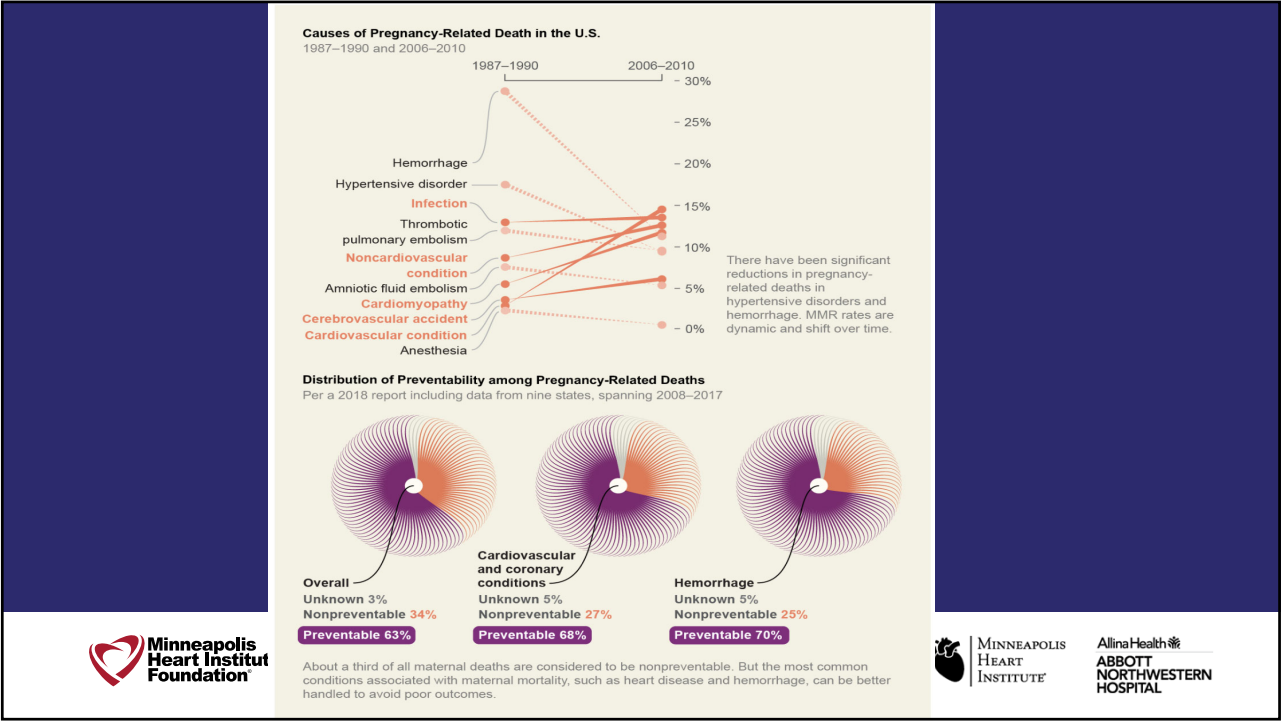
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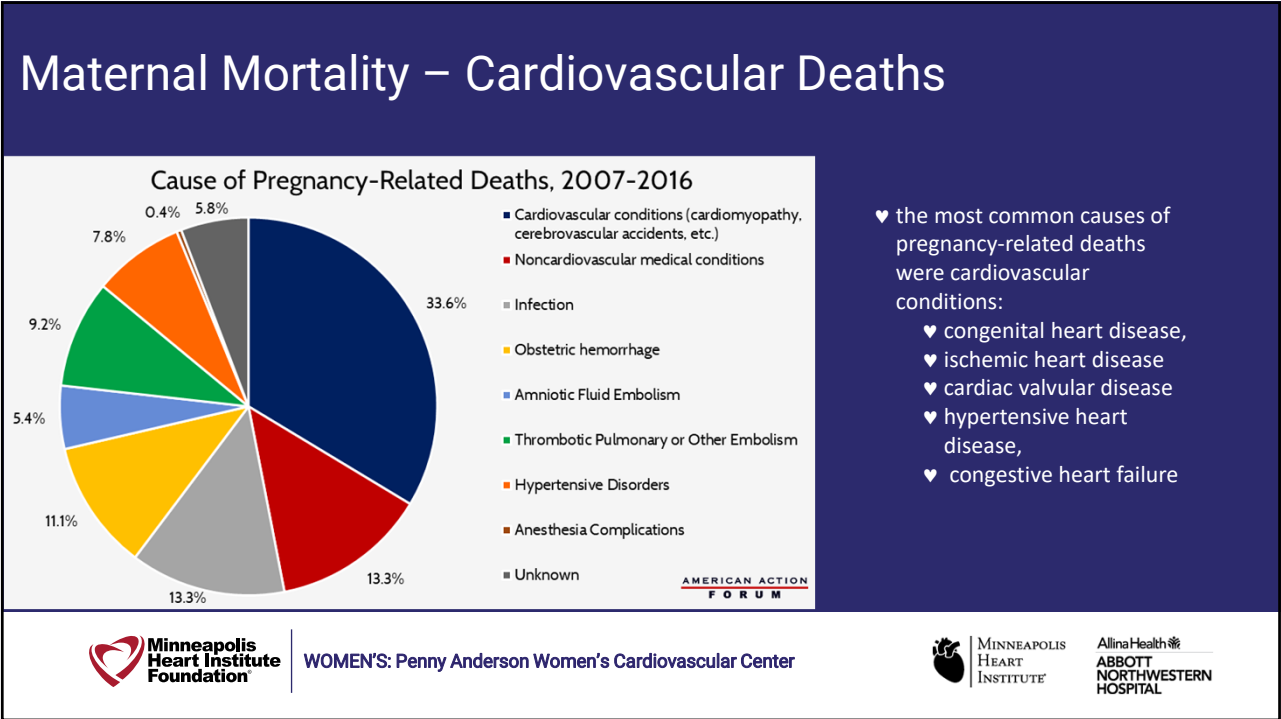
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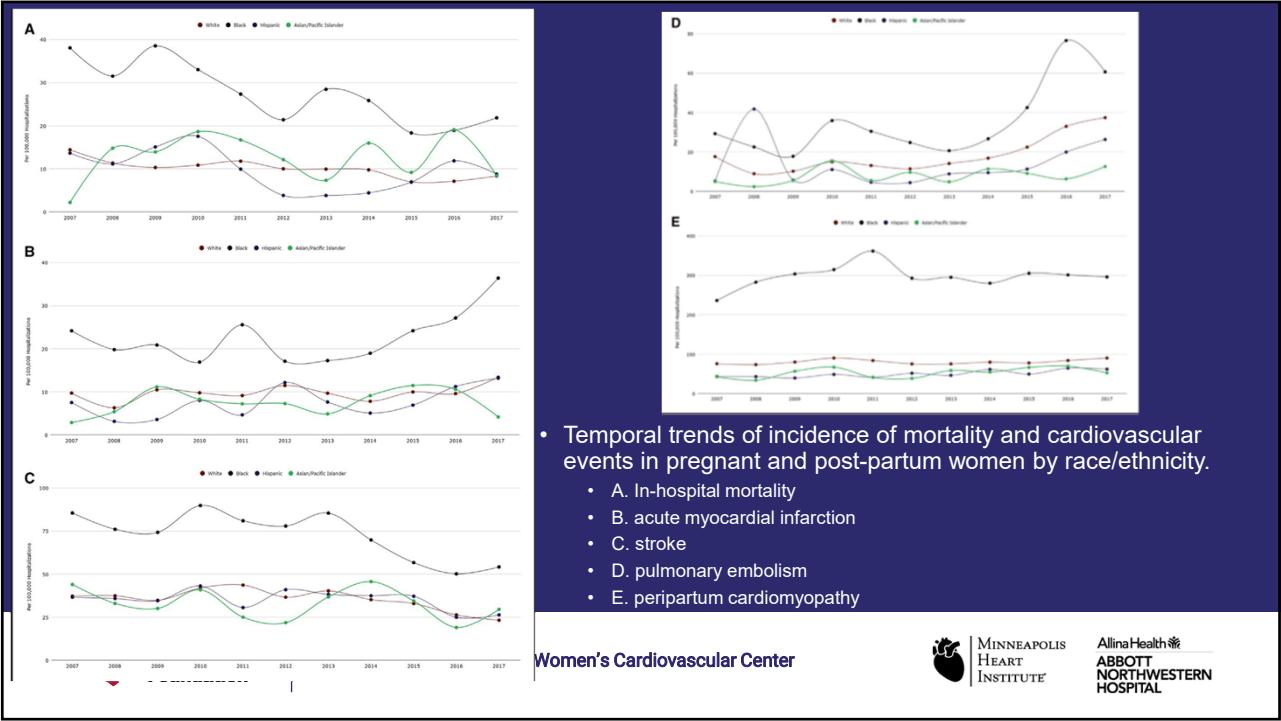
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First pregnancies should be utilized as an early life stress test to identify women who may have CVD risk

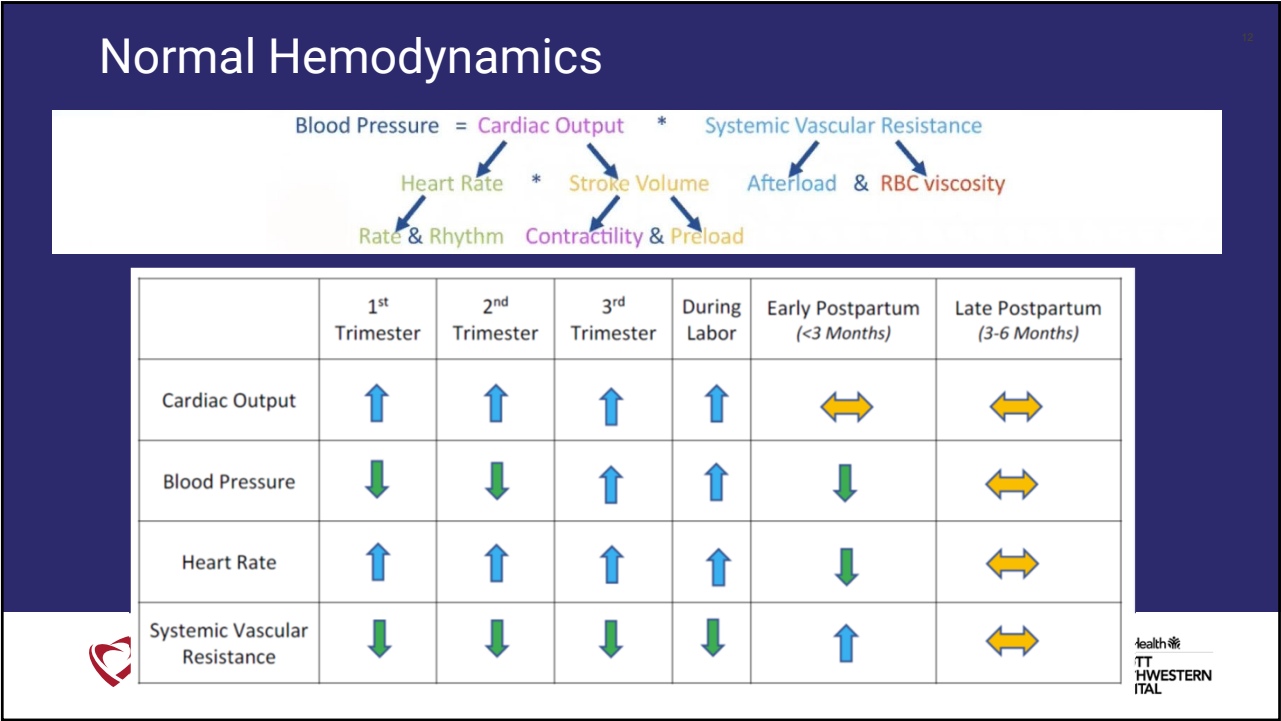
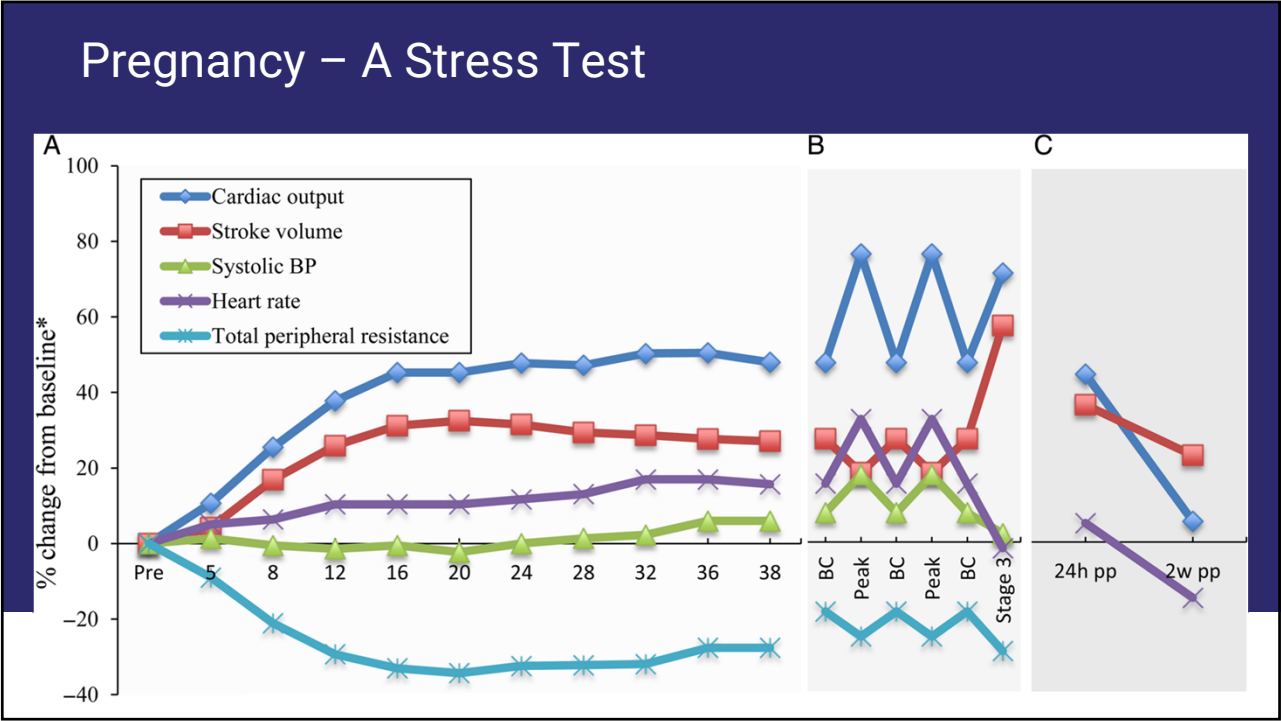
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10



# Solutions



ALLIANCE FOR INNOVATION  
ON MATERNAL HEALTH

Program	Key stakeholders	Implementation	Scope
AIM	HRSA cooperative agreement with ACOG	Statewide through POCs working at the facility level	Data-driven maternal safety and quality improvement initiative based on interdisciplinary consensus-based practices to improve maternal safety and outcomes. The Council on Patient Safety in Women's Health Care and the AIM Program have developed 10 patient safety bundles targeting maternal health since 2013.
ERASE MM	CDC and states	State jurisdictions	Program developed from maternal mortality review committees using common data collection and sharing of findings.
PQCs	CDC and states	States	These are networks of clinical teams, public health professionals, and other stakeholders that work together to improve pregnancy, newborn, and infant outcomes at the state level.
Perinatal Care Services Certification	The Joint Commission	National at facilities	Facilities are expected to meet standards and follow clinical practice guidelines and are evaluated against 6 evidence-based core measures that have been endorsed by the National Quality Forum.
LOCAtE	CDC	National at facilities or Departments of Health	The CDC developed CDC LOCAtE on the basis of the recent guidelines and policy statements issued by the American Academy of Pediatrics, ACOG, and SMFM. The tool is intended to provide a standardized facility assessment and to promote collaborative approaches to strengthen systems of risk-appropriate care.
Levels of Maternal Care	ACOG/SMFM and CDC	National at facilities	In 2015, the ACOG and SMFM released Levels of Maternal Care. This introduced uniform designations for levels of maternal care at birthing facilities that address maternal health needs, with the goal of reducing maternal morbidity and mortality in the United States.
Maternal Health Innovation Programs	HRSA and states	States	Design, implement, and evaluate innovations in maternal service delivery in 9 states.
Women's Preventive Services Initiative	HHS, HRSA, and ACOG	National	ACOG launched the Women's Preventive Services Initiative, engaging a coalition of national health professional organizations and consumer and patient advocates with expertise in women's health across the life span to develop, review, and update recommendations for women's preventive health care services, including HRSA-sponsored Women's Preventive Services Guidelines.
Cardio-Obstetrics Programs	States, AHA, and ACOG	Facilities	Pregnancy heart teams provide a multidisciplinary team-based approach to the assessment and management of pregnant individuals who have underlying cardiovascular disease or develop it during pregnancy.

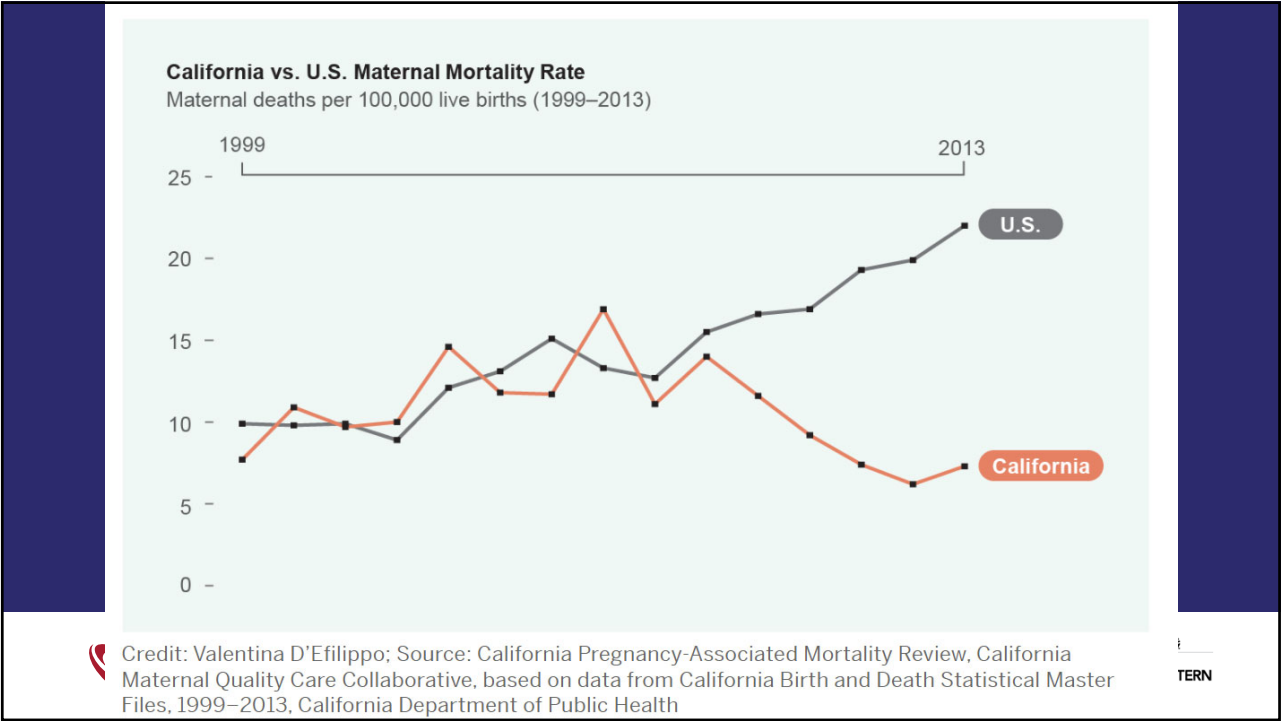


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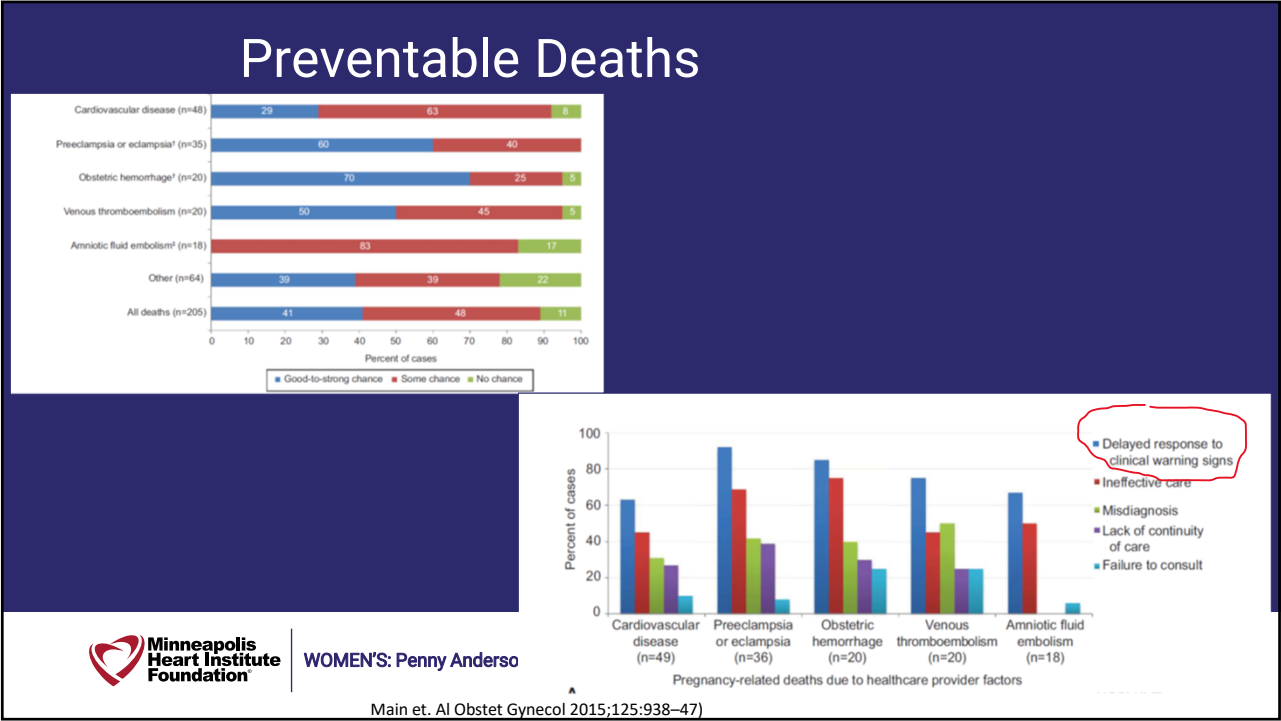
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13

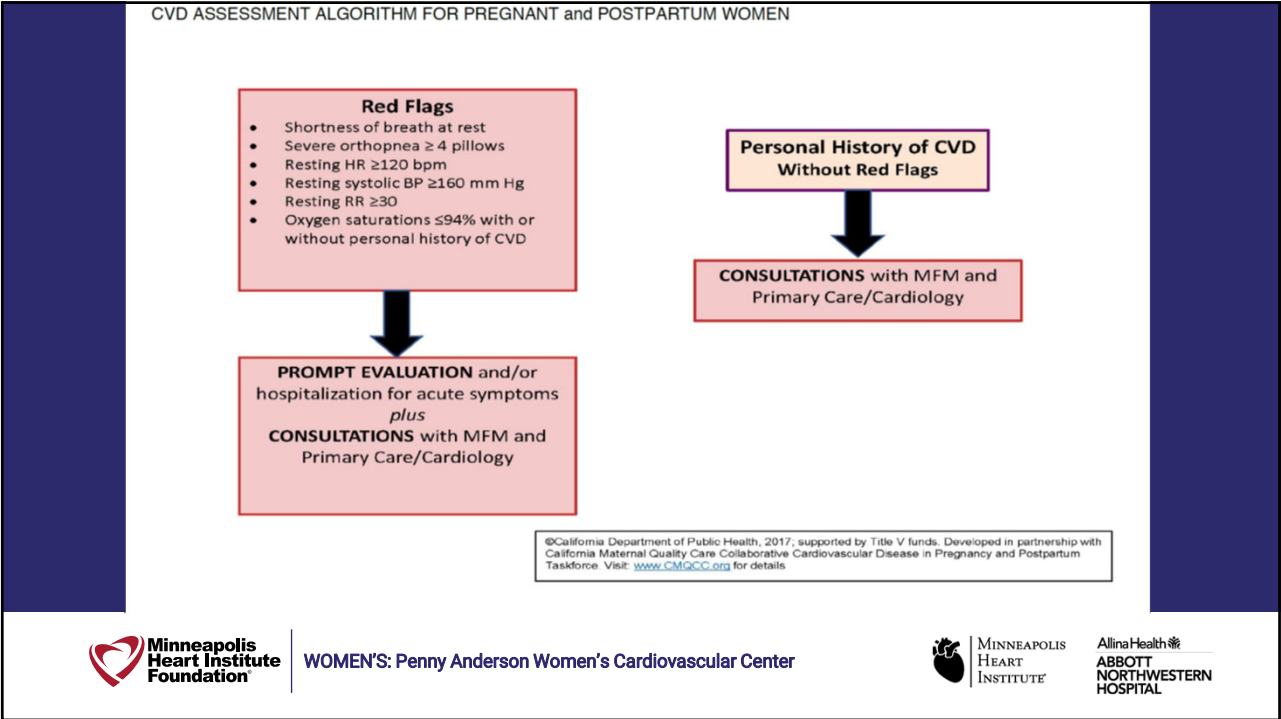


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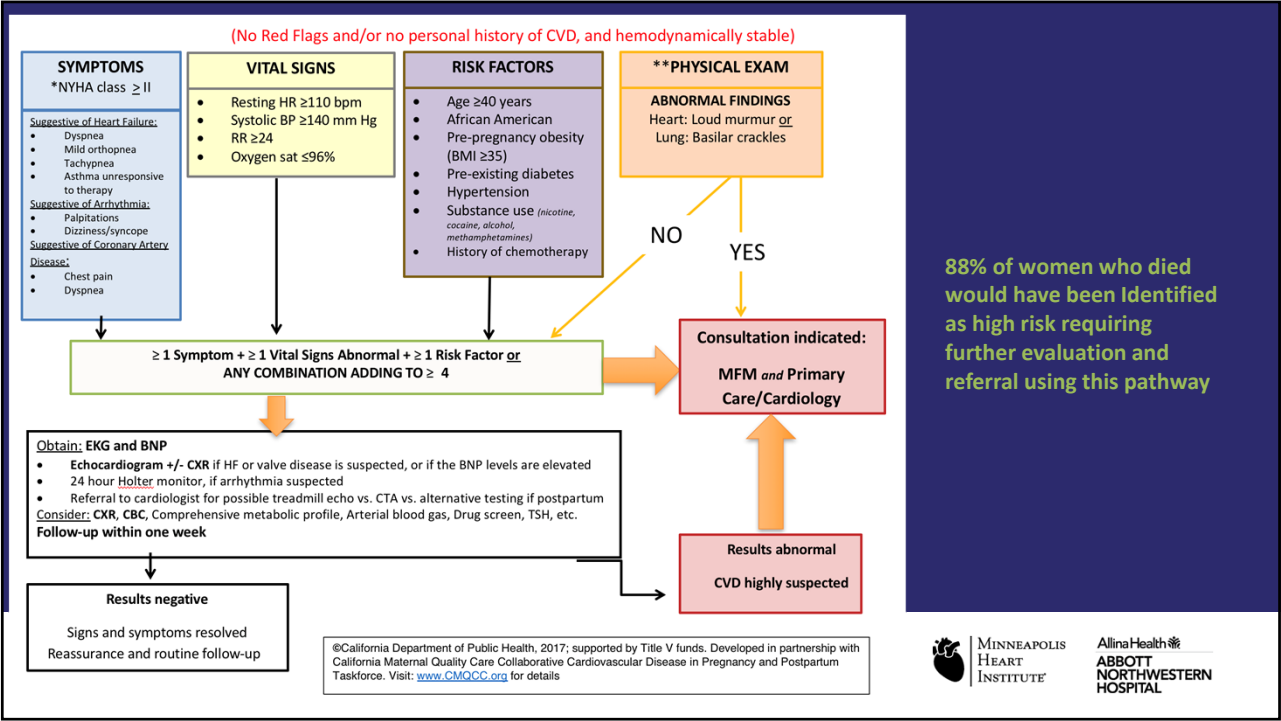




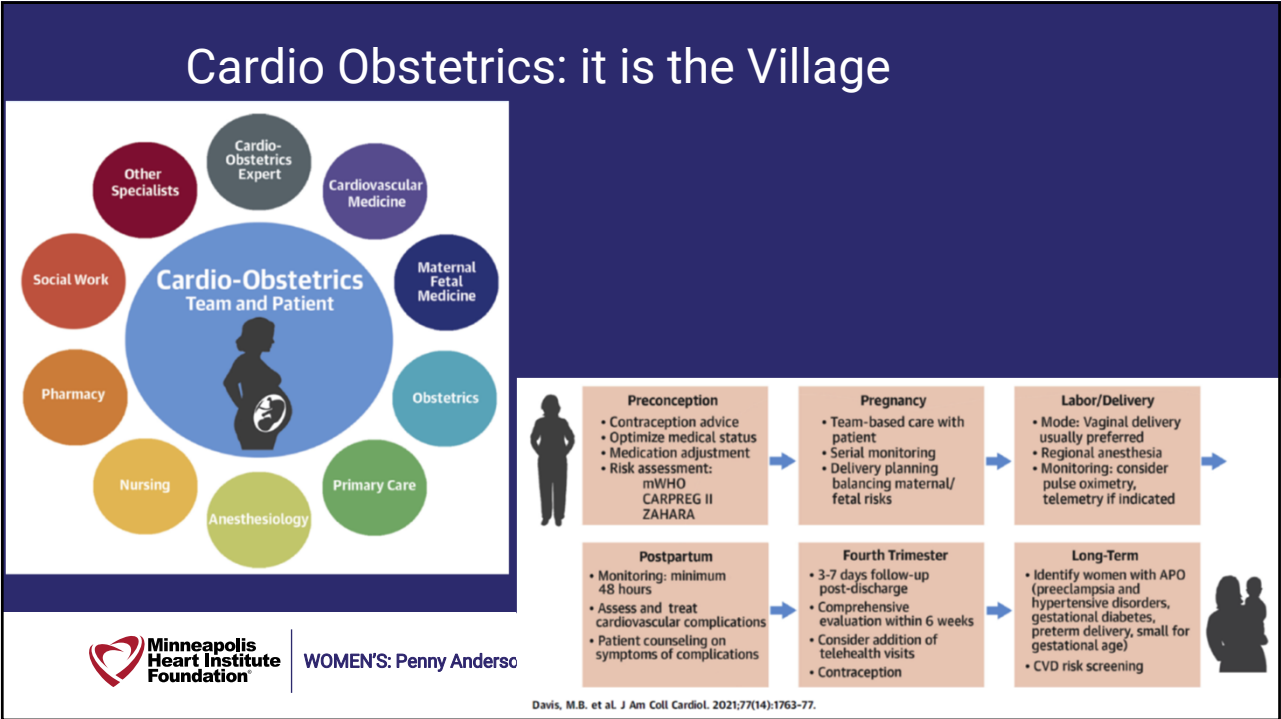
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18

# Multidisciplinary Approach to Peripartum Care

- Symptoms of pregnancy = cardiac symptoms
- Women with CV symptoms should be evaluated
- PREGNANCY AS AN ETIOLOGY OF SYMPTOMS SHOULD BE A DIAGNOSIS OF EXCLUSION
- Women with apo/pregnancy induced complications need follow up and management of risk factors for cvd (pregnancy is a stress test)



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## Cardio OB scoring

TABLE 2 ZAHARA Risk Prediction Model Derived From Patients With Congenital Heart Disease

ZAHARA Predictors	Points
Prior arrhythmia	1.5
Cardiac medications before pregnancy	1.5
NYHA functional class ≥II	0.75
Left heart obstruction	2.5
Moderate or severe mitral regurgitation	0.75
Moderate or severe tricuspid regurgitation	0.75
Mechanical valve	4.25
Cyanotic heart disease (corrected or uncorrected)	1
ZAHARA Score	Predicted Risk, %
0-0.5	2.9
0.51-1.50	7.5
1.51-2.50	17.5
2.51-3.50	43.1
>3.50	70.0

NYHA = New York Heart Association; ZAHARA = Zwangerschap bij Aangeboren HARTafwijking (Pregnancy in Women With Congenital Heart Disease) study.

TABLE 1 CARPREG II Risk Prediction Model

CARPREG II Predictors	Points
Prior cardiac event or arrhythmia	3
Baseline NYHA functional class III to IV or cyanosis	3
Mechanical valve	3
Ventricular dysfunction	2
High-risk left-sided valve disease/LVOT obstruction	2
Pulmonary hypertension	2
Coronary artery disease	2
High-risk aortopathy	2
No prior cardiac intervention	1
Late pregnancy assessment	1
CARPREG II Score	Predicted Risk, %
0 to 1	5
2	10
3	15
4	22
>4	41

CARPREG = Cardiac Disease in Pregnancy Study; LVOT = left ventricular outflow tract; NYHA = New York Heart Association.

TABLE 3 Modified WHO Risk Stratification Model

Modified WHO Class	Conditions	Predicted Risk, %
I—No higher risk than the general population	Uncomplicated, small or mild lesions including pulmonary stenosis, VSD, PDA, and mitral valve prolapse with no more than trivial mitral regurgitation Successfully repaired simple lesions including ostium secundum ASD, VSD, PDA, and TAPVD Isolated PVCs and PACs	2.5-5
II—Small increased risk of maternal morbidity and mortality	Unoperated ASD Repaired tetralogy of Fallot Most arrhythmias Coarctation of the aorta without significant gradient or aneurysm (repaired or unrepaired) Long QT syndrome	5.7-10.5
II to III	Mild LV impairment Hypertrophic cardiomyopathy Marfan syndrome without aortic dilation Heart transplant Native or tissue valve disease not considered WHO class IV Bicuspid aortic valve without aortic dilation	10-19
III—Significant risk of maternal morbidity and mortality	Mechanical valve Systemic RV Post-Fontan operation Cyanotic heart disease Other complex congenital heart repair Aortic dilation without known fibrinogen disease Coarctation of the aorta with residual gradient or aneurysm (repaired or unrepaired) Marfan syndrome with aortic root dilation <45 mm or following aortic replacement Bicuspid aortic valve with aortic root dilation 45 to 50 mm	19-27
IV—Pregnancy contraindicated	Pulmonary arterial hypertension of any cause Severe left ventricular dysfunction (LVEF <30% or NYHA functional class III to IV) Previous peripartum cardiomyopathy with any residual impairment of LV function Severe left heart obstruction (AVA <1 cm <sup>2</sup> or peak gradient >50 mm Hg; MVA <1.5 cm <sup>2</sup> ) Marfan syndrome with aortic dilation >45 mm Bicuspid aortic valve with aortic dilation >50 mm	40-100

ASD = atrial septal defect; AVA = aortic valve area; LV = left ventricle; LVEF = left ventricular ejection fraction; MVA = mitral valve area; NYHA = New York Heart Association; PAC = premature atrial contraction; PDA = patent ductus arteriosus; PVC = premature ventricular contraction; RV = right ventricle; TAPVD = total anomalous pulmonary venous drainage; WHO = World Health Organization.




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	mWHO I	mWHO II	mWHO II-III	mWHO III	mWHO IV
Care during pregnancy	Local hospital	Local hospital	Referral hospital	Expert centre for pregnancy and cardiac disease	Expert centre for pregnancy and cardiac disease
Minimal follow-up visits during pregnancy	Once or twice	Once per trimester	Bimonthly	Monthly or bimonthly	Monthly
Location of delivery	Local hospital	Local hospital	Referral hospital	Expert centre for pregnancy and cardiac disease	Expert centre for pregnancy and cardiac disease

Management


- Echocardiography is the modality of choice recommended for all valvular management, evaluation at baseline, evaluation for aorta.
- Any change in cv signs or symptoms should lead to echocardiogram as first line management
- Adding BNP (usually stable through the duration of pregnancy)
- Based on WHO class echoes are often every trimester to every month



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## Abbott Cardio-Obstetrics Program


- Cardiologists and Maternal Fetal Medicine (MFM) specialists work together to provide evidence-based care to pregnant women with new or pre-existing CVD or CVD symptoms.
- All patients have an RN Care Coordinator; most visits are conducted with multi-disciplinary providers (e.g., cardiology, perinatology, pharmacy).
- Program components: Preconception counseling, risk stratification, prenatal care, development of a collaborative individualized pregnancy and birth plan, and coordinated postpartum care.
- All cases are presented at conference prior to delivery and postpartum planning.



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Demographics and Clinical Characteristics of women enrolled in the CVOB program and historical comparisons		
	CVOB 2018-2019 (n=113)	Comparison 2016-2017 (n=338)
<b>mWHO, n (%)*</b>		
none	10 (9)	156 (46)
I	15 (13)	67 (20)
II	24 (21)	59 (17)
II-III	37 (33)	29 (9)
III	22 (19)	19 (6)
IV	5 (5)	8 (2)
<b>Carpreg2, n (%)*</b>		
0	56 (49)	218 (65)
1	0	22 (7)
2	12 (11)	11 (3)
3	38 (34)	69 (21)
4+	7 (6)	16 (4)
Missing	0	2
* p < 0.01, ** p < 0.05		
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23

Demographics and Clinical Characteristics of women enrolled in the CVOB program and historical comparisons		
	CVOB 2018-2019 (n=113)	Comparison 2016-2017 (n=338)
<b>Comorbidities, n (%)</b>		
CAD	2 (2)	5 (2)
HTN	21 (19)	40 (12)
Hyperlipidemia	4 (4)	6 (2)
Cerebrovascular disease	3 (3)	5 (2)
Renal Disease**	4 (4)	1 (0.3)
Pulmonary HTN	0	0
Heart Failure	3 (3)	3 (1)
Cardiac Arrest	1 (1)	4 (1)
Aortic Dissection	1 (1)	0
Cardiac Valve Insufficiency*	17 (15)	13 (4)
Cardiac Valve Stenosis*	14 (12)	13 (4)
* p < 0.01, ** p < 0.05		
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24

Demographics and Clinical Characteristics of women  
enrolled in the CVOB program and historical comparisons

	CVOB 2018-2019 (n=113)	Comparison 2016-2017 (n=338)
Parity, n (%)		
0	41 (36)	126 (38)
1	41 (36)	98 (29)
2+	31 (28)	114 (33)
Age, mean(SD)	30.0 (5.5)	30.6 (5.3)
Race, n (%)**		
American Indian	2 (2)	2 (1)
Asian	5 (5)	14 (4)
Black or African American	21 (19)	57 (17)
Multiracial	9 (8)	7 (2)
White	73 (66)	254 (76)
Missing	3	4
Ethnicity, % Hispanic	6 (5)	15 (4)



\* p < 0.01, \*\* p < 0.05

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Demographics and Clinical Characteristics of women  
enrolled in the CVOB program and historical comparisons

	CVOB 2018-2019 (n=113)	Comparison 2016-2017 (n=338)
<b>Medications prior to pregnancy, n (%)</b>		
Anticoagulation	8 (7)	10 (3)
Anti-cholesterol	1 (0.9)	7 (2.1)
Anti-platelet	8 (7)	21 (6)
Anti-hypertensive	24 (21)	72 (21)
Antiarrhythmic	4 (3.5)	5 (1.5)
Antidepressant	22 (19)	57 (17)
<b>Medications during pregnancy, n (%)</b>		
Anticoagulation	6 (5)	9 (3)
Anti-cholesterol	0	3 (0.9)
Anti-platelet*	30 (27)	29 (9)
Anti-hypertensive*	40 (35)	61 (18)
Antiarrhythmic	5 (4.4)	6 (1.8)
Antidepressant	19 (17)	43 (13)



\* p < 0.01, \*\* p < 0.05

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26

## Results (Demographics)

- CVOB patients were more racially diverse (34% nonwhite vs 24% in the comparison group)
- There was no difference with regard to parity, age, or Hispanic ethnicity.
- CVOB group had higher rates of valvular heart disease (27% vs 8%)
- CVOB patients were had higher CVD risk scores based on mWHO and CARPREG2
- Antiplatelet and Anti-hypertensive use was higher during pregnancy among CVOB patients.



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27

## Cardiology care and outcomes during pregnancy

Patients experiencing specific tests, and events during pregnancy	CVOB 2018-2019 (n=102)	Comparison 2016-2017 (n=102)
Number of cardiology tests, median (IQR)	8 (5, 12.8)	5 (3, 7)*
Cardiology tests during pregnancy, n (%)		
EKG	71 (70)	62 (61)
Echocardiogram	93 (91)	78 (76)*
Cardiac CT Scan	6 (6)	3 (3)
Cardiac MRI	11 (11)	3 (3)**
Holter/ Zio patch monitoring	38 (37)	9 (9)*
ED visits during pregnancy, n (%)	22 (22)	34 (33)
Inpatient admissions during pregnancy, n (%)	17 (17)	14 (14)
Cardiology complications during pregnancy, n(%)	41 (40)	31 (30)



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\* p < 0.01, \*\* p < 0.05

28

Delivery and postpartum outcomes		
	CVOB 2018-2019 (n=102)	Comparison 2016-2017 (n=102)
Gestational age at delivery, median (IQR)	39.00 (37.46, 39.29)	39.14 (37.71, 39.68)
Preterm (< 37 weeks gestation), n (%)	14 (14)	13 (13)
Length of Stay at Delivery, median (IQR)		
Vaginal	2.66 (2.13, 3.20)	2.13 (1.84, 2.52)*
Cesarean	3.35 (3.15, 5.85)	3.68 (3.17, 4.29)
ICU admission during delivery, n (%)	10 (10)	4 (4)
ICU LOS, median (IQR)	2.60 (1.91, 4.21)	2.16 (1.28, 3.13)
Telemetry during hospital stay, n(%)	33 (32)	19 (19)**
Inpatient or ED visits in 6 months postpartum, n (%)	35 (34)	72 (71)*
Any perinatal provider visit postpartum, n (%)	46 (45)	23 (23)*
Cardiology complications postpartum, n(%)	63 (62)	60 (59)



\* p < 0.01, \*\* p < 0.05




29

## Results



Women who received care in the CVOB program:

- had more cardiology tests during pregnancy relative to pre-program controls (median of 8 tests vs 5; p <0.001).
- experienced a ½ day longer LOS (median of 2.66 vs 2.13 days; p=0.006) for vaginal deliveries.
- had more telemetry during pregnancy and were more likely to see a perinatologist postpartum.
- were less likely to have inpatient or ED visits in the 6 months postpartum (34% vs 71%; p <0.001).

There was no significant difference in cardiology complications during pregnancy or postpartum.



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30



# Conclusions

- CVOB patients were more closely monitored by cardiology and MFM during pregnancy as well as postpartum (i.e. more tests, telemetry, longer LOS).
- In a multidisciplinary, non university CVOB program, coordination of care and monitoring during pregnancy may have contributed to fewer postpartum emergency visits and readmissions.



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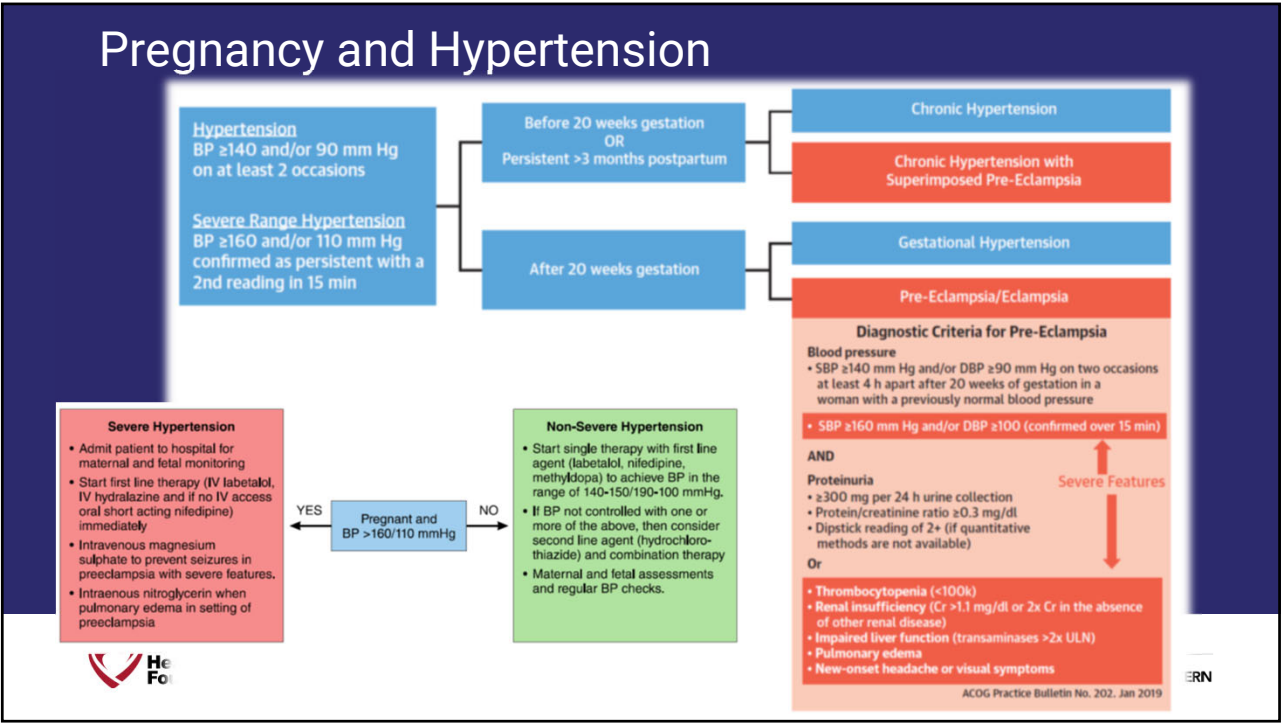
# Hypertensive Disorders of Pregnancy at Allina Health

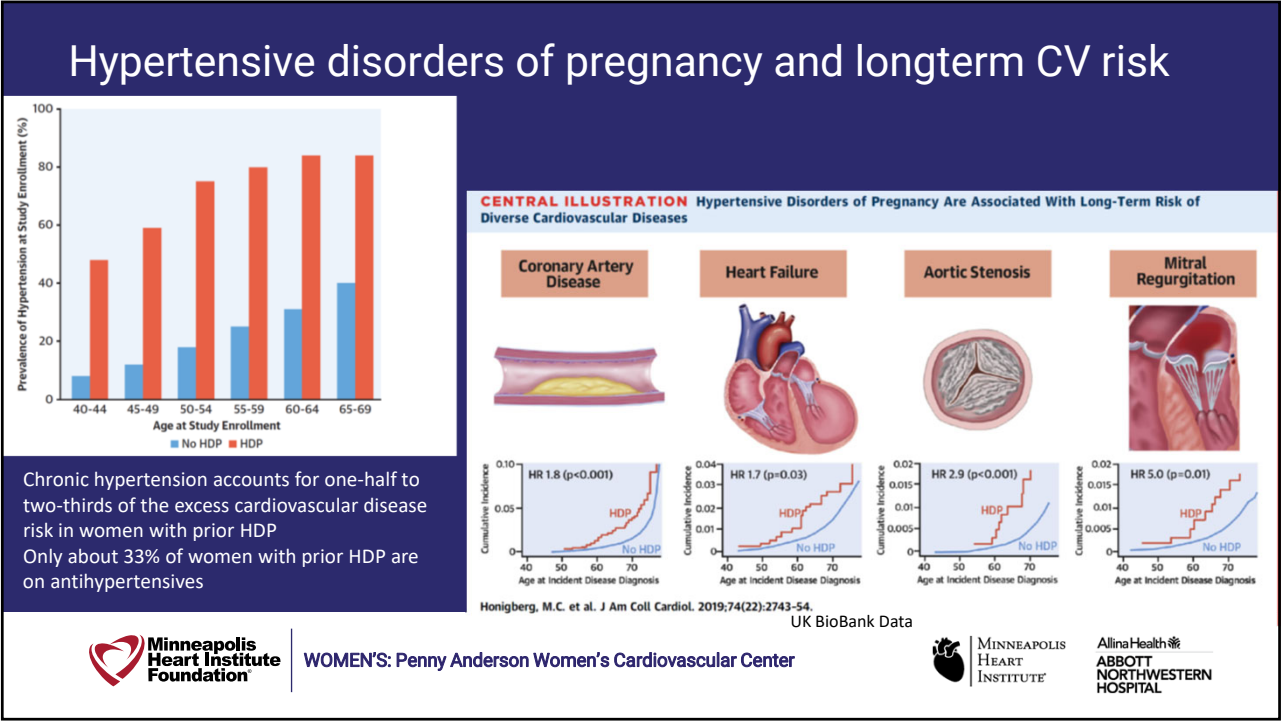


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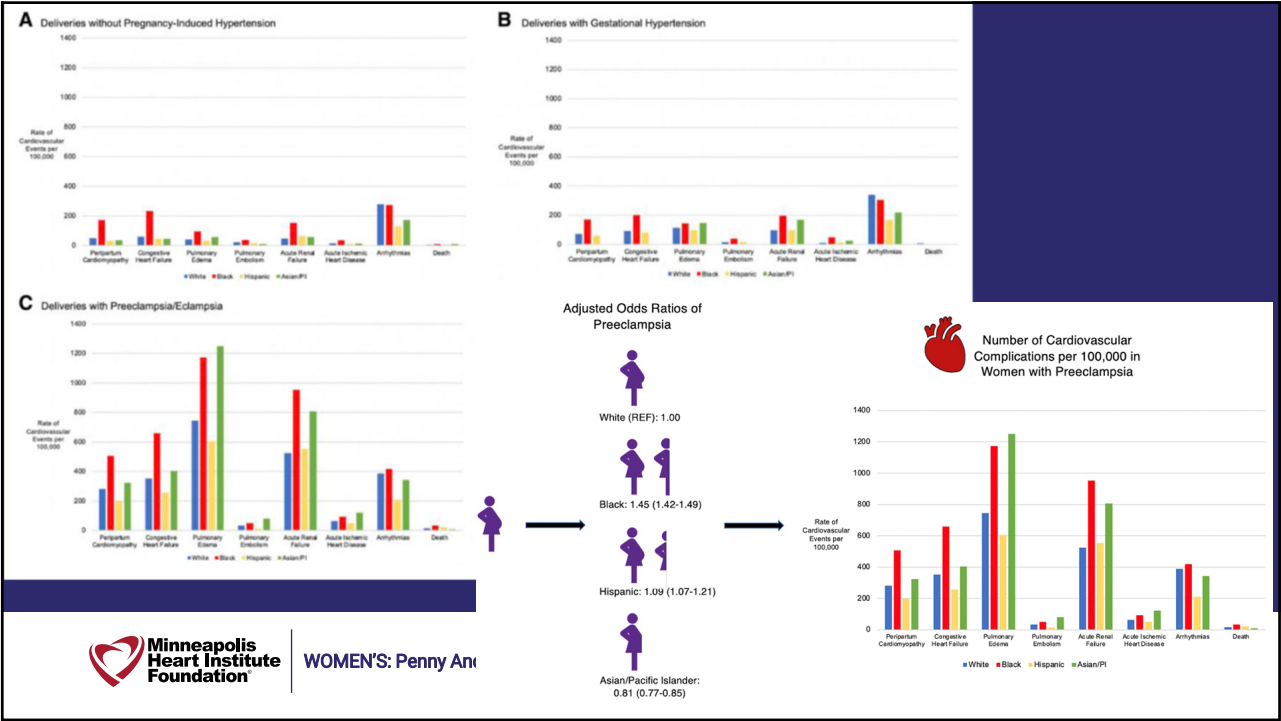


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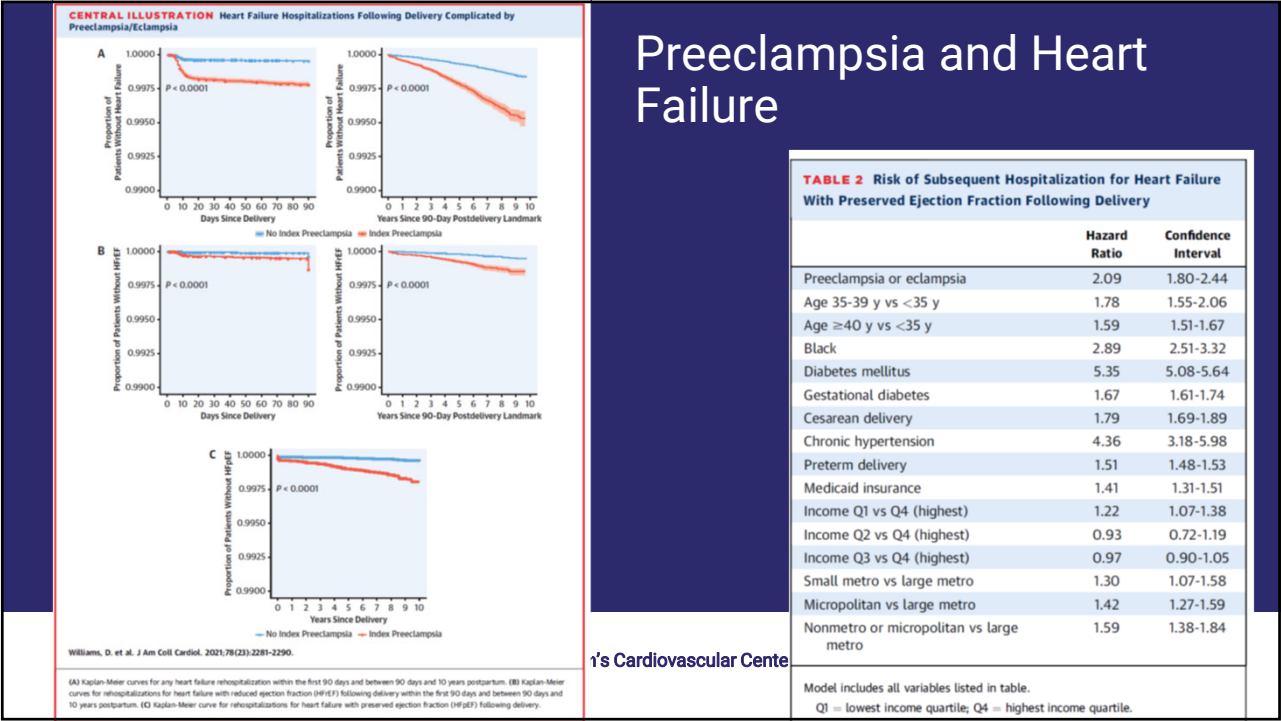




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36



37

## Post partum Hypertension and Readmission

- Preeclampsia/hypertension are often associated with readmission
  - Readmission associated with SBP ≥140/90 mm Hg within 24 hours before discharge increased the odds of readmission (adjusted odds ratio, 1.98; 95% confidence interval, 1.37–2.87).
  - 2 or more elevated blood pressure values further increased the odds (adjusted odds ratio, 3.14; 95% confidence interval, 2.33–4.24)
- Majority of women are admitted 5-7 days postpartum

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Bruce et al. *Am J Obstet Gynecol* MFM. 2021 May 12;3(5):100397.

38

## New Post Partum HTN orders at Allina (went live February 22)

- Updated Guideline for Care
  - **Care of Patients with Hypertensive Disorders in Pregnancy and Postpartum**
- Medication management of HTN may be more aggressive in the postpartum period and the interval between pregnancies as placental perfusion is no longer a consideration
- PP goal to maintain BP < 130/80 mmHg before discharge
  - Based on AHA and NICE recommendations
- Use oral (longer-acting) antihypertensive agents to treat HTN
- Recommend initiating an oral antihypertensive medication for persistent BP > 140/90
  - Lifestyle modification, education, appropriate follow-up care



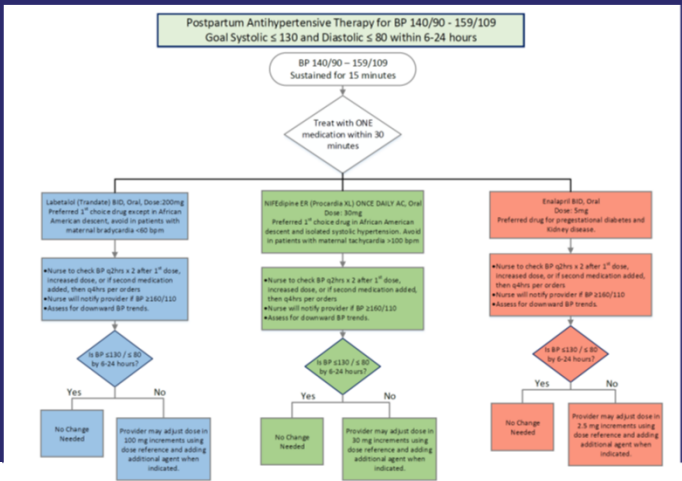
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## New Post Partum HTN Order Set



### Antihypertensive Dosing Reference

Drug	Usual dose	Consider a second agent	Maximum dose for HTN	Onset of Action Peak effect
Nifedipine XL	30 mg daily	60 mg daily	Up to 120 mg/day	20-30 minutes Peak 4-7 hours
Labetalol	200 mg BID	300 mg BID	Not to exceed 2400 mg/day	15-20 minutes Peak 2-4 hours
Enalapril	5-10 mg BID	10 mg BID	40 mg/day	60 min Peak 4-6 hours
Hydralazine	10 mg q 6 hours	25 mg q 6 hours	300 mg/day	30-60 minutes Peak 1-2 hours
Atenolol	50 mg daily	100 mg daily	100 mg/day	60 minutes Peak 3 hours

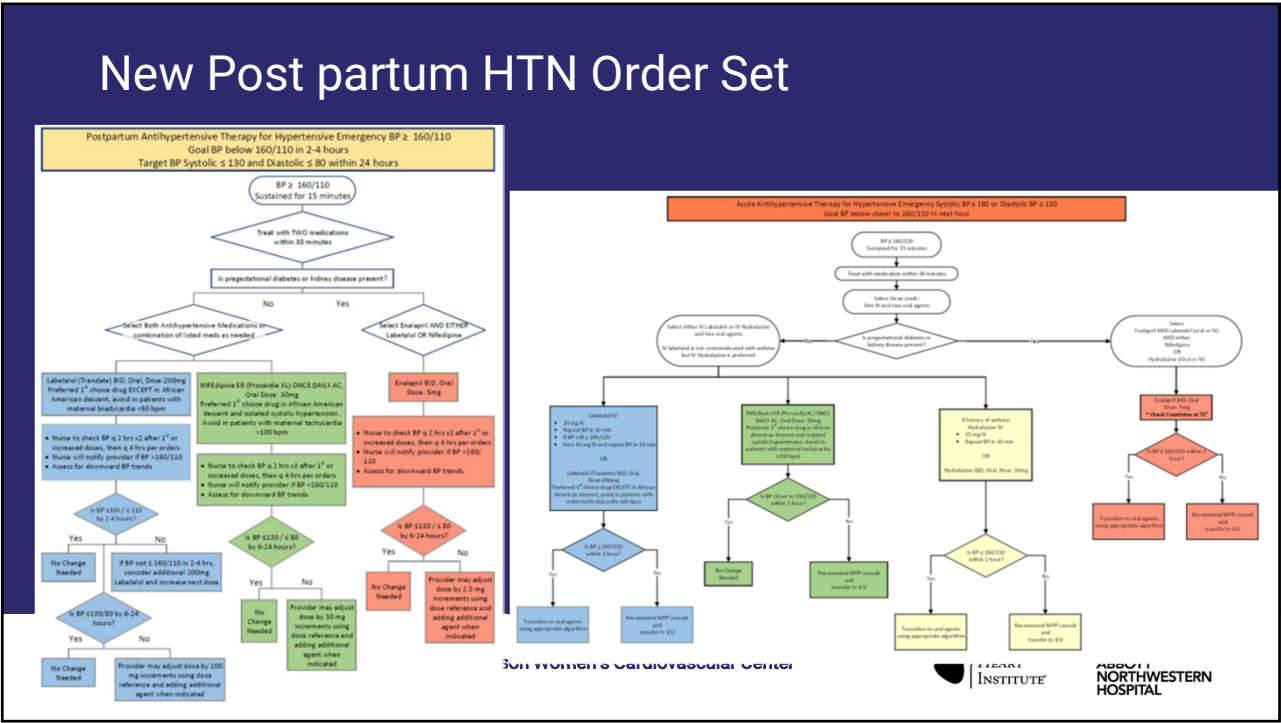


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41

## Other Recommendations

- **Diuretics to reduce the risk of cardiac dysfunction**
  - BNP > 100 pg/ml – consider lasix
- **Standard education**
  - Early warning signs
  - When to seek emergency care
  - Risk for cardiovascular disease
- **BP monitoring and f/u visits after discharge**
- **Recommendations for consultation and further care and follow-up**
  - MFM, Cardiology and APRN PP HTN Clinic after 12 weeks postpartum

### HYPERTENSIVE DISORDERS OF PREGNANCY

Initial postpartum BP normalization Day 0-5

Elevated BP after discharge Day 5-8

Postpartum furosemide Day 1-5

**READMISSION for elevated postpartum BP requiring treatment**

#### Clinical Implications

Need to treat **13 women** to prevent 1 woman from having persistent postpartum BP

Improved resolution of hypertension

- 60% reduction in persistently elevated BPs at 7 days

Faster time to hypertension recovery

- 8.5 vs 10.5 days

Both findings noted most prominently in women with non-severe HDP

Joana Lopes Perdigao, Hypertension, Volume:

**Minneapolis Heart Institute Foundation**

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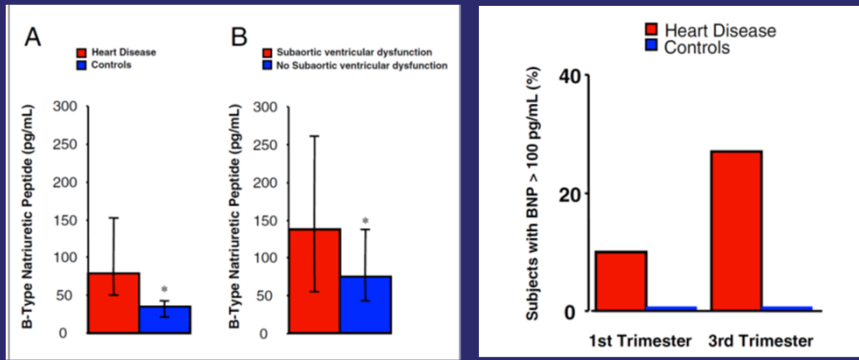
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42



# Cardiac Markers and Pregnancy: BNP

- BNP  $\leq 100$  pg/ml had a negative predictive value of 100% for identifying events during pregnancy.
- Pregnant BNP levels were approximately twice as high as the nonpregnant BNP levels.
- BNP can be used longitudinally to follow a woman through pregnancy





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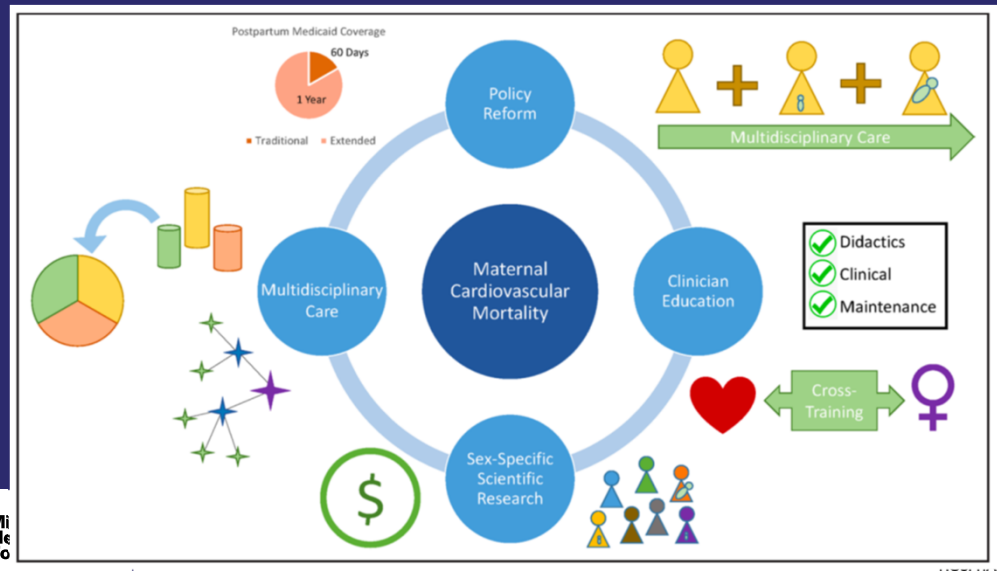
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43

# A Call to Action





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44


# A Call to Action

- In 2016, 313 530 hospital discharges for HDP, 128 240 for preexisting diabetes and gestational diabetes, 362 955 for PTB, and 78 820 for SGA/low birth weight.
- In 2016, 73 485 visits to the ED for HDP, 19 903 for preexisting diabetes and gestational diabetes, 101 047 for PTB, and 5985 for SGA/low birth weight
- Pregnancy and postpartum care accounted for **\$71.3 billion** (\$64.9–\$77.7 billion) in total health care spending in 2016.
- Complications related to HDP and PTB were estimated to account for **\$5.5 billion** (\$4.8–\$6.3 billion) and **\$28.2 billion** (21.8–37.6 billion), respectively

AHA STATISTICAL UPDATE


Heart Disease and Stroke Statistics—  
2021 Update  
A Report From the American Heart Association

11. ADVERSE PREGNANCY OUTCOMES




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**TABLE 1 A Stepwise Approach to Developing a Niche in Cardio-Obstetrics**


Area of Intervention	Focused Intervention for FITs/ECPs, Institutions and Professional Science Organizations, and Competency Management Committees
Understanding the disease spectrum	<ul style="list-style-type: none"><li>• Understanding the social determinants of health and poor pregnancy outcomes</li><li>• Improving knowledge on APOs and long-term CV risks</li><li>• Incorporating detailed pregnancy history in routine encounters</li><li>• Understanding physiology of pregnancy and its effects on CV system</li><li>• Learning pharmacotherapeutics in pregnancy</li></ul>
Developing a pregnancy heart team	<ul style="list-style-type: none"><li>• Need for short- and long-term follow-up of women with APOs</li><li>• Developing multidisciplinary team-based care for high-risk women</li><li>• Preconception CV risk assessment and pregnancy planning</li><li>• Implement quality improvement projects and hospital protocols</li><li>• Volunteering on hospital and state maternal mortality review committees</li></ul>
Improving research and registry data	<ul style="list-style-type: none"><li>• Studying subclinical and overt CV dysfunction in APOs and acquired heart disease in pregnancy</li><li>• Pregnancy outcomes in women with congenital heart disease and peripartum cardiomyopathy</li><li>• Large, multicenter phenomic and proteomic investigations of APOs</li><li>• Understanding the role of placental ischemia and antiangiogenic proteins in the etiology of APOs</li><li>• Population data research associations of APOs and long-term CV risks</li><li>• Outcomes research on healthy lifestyle interventions in women with CVD risk enhancers</li></ul>
Improving training and education	<ul style="list-style-type: none"><li>• Designing and implementing curricula in fellowship</li><li>• Increasing collaborative sessions on CVD in pregnancy at national societal meetings</li><li>• Developing multidisciplinary grand rounds</li><li>• Revising COCATS to incorporate modules on CVD in pregnancy</li></ul>

APO – adverse pregnancy outcome; COCATS – Core Cardiovascular Training Statement; CV – cardiovascular; CVD – cardiovascular

**TABLE 2 Key Team Members Focused on a Multidisciplinary Approach to the Care of the Cardio-Obstetric Patient**

Physicians and surgeons	Allied health professionals and cardiovascular team members
Cardiologist (and cardiac subspecialists)	Mental health specialist
Obstetrician/maternal fetal medicine specialist	Nurse specialist/physician assistant
Cardiac anesthesiologist	Pharmacist
Cardiothoracic surgeon	Geneticist
Pediatric cardiologist	
Neonatologist	
Pulmonary hypertension specialist	
Family medicine/internist	

## CVOB PROGRAMS, Training Changes



Minneapolis  
Heart Institute  
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46



## Research

## Maternal Mortality in the United States and the HOPE Registry

Anna Grodzinsky, MD<sup>1,2,\*</sup>  
Karen Florio, DO<sup>1,2</sup>  
John A. Spertus, MD MPH<sup>1,2</sup>

1. Describe the presenting features of pregnant women with heart disease. Therein, we plan to describe the health status (symptoms, function, and quality of life) outcomes for pregnant women with structural heart disease, heart failure, and coronary disease.
2. Describe the antenatal monitoring patterns, growth, and perinatal outcomes of babies whose moms have heart disease.
3. Describe the management of pregnant women with heart disease and its association with maternal and fetal outcomes.
4. Document contraception counseling and patient perception thereof.
5. Describe anesthesia and mode and timing of delivery planning.



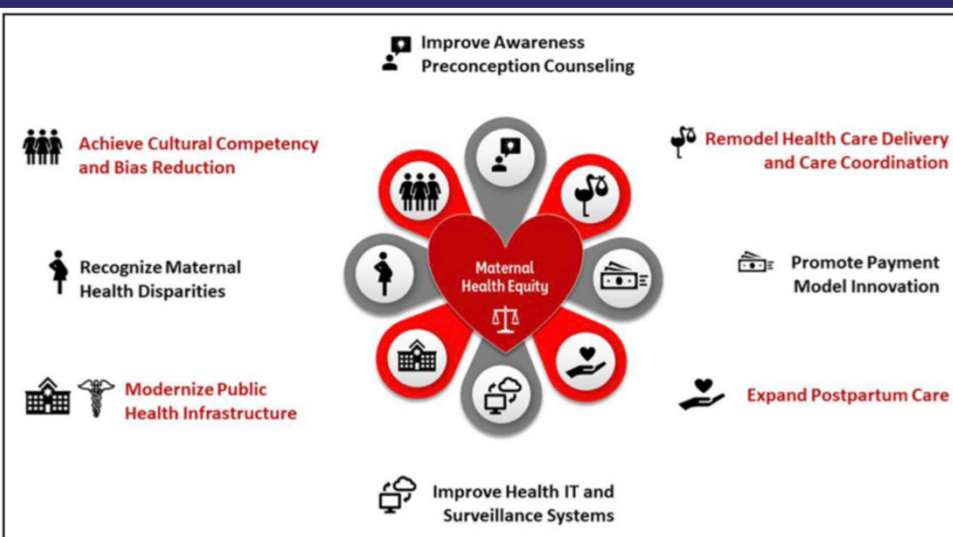
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47

# Policy



**Figure.** A multipronged approach to achieving sustainable maternal health equity. IT indicates information technology.



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48

## Conclusions

- Maternal Mortality in the US continues to Rise
- CVD is now the number one cause of maternal M and M
- Cardio Obstetrics teams, with risk assessment, delivery planning decrease maternal M and M
- Pregnancy and post partum symptoms = CV symptoms and should be assessed
- Policy, Research and Education changes are needed to impact our woeful mortality rates



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