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An Analysis of Cardiovascular and Hypertensive Disease in Pregnancy: Outcomes and Disparities

Rita W. Driggers, M.D., F.A.C.O.G.

Associate Professor of Gynecology and Obstetrics

Johns Hopkins University School of Medicine

Medical Director, Maternal Fetal Medicine

Sibley Memorial Hospital Johns Hopkins Medicine

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Presenter

Rita W. Driggers, M.D., F.A.C.O.G.

**Associate Professor of Gynecology and Obstetrics Johns
Hopkins University School of Medicine**

**Medical Director, Maternal Fetal Medicine Sibley
Memorial Hospital Johns Hopkins Medicine**

Washington, D.C.

Rita W. Driggers, M.D., F.A.C.O.G.



Dr. Rita Driggers attended medical school at the University of Tennessee followed by residency in Obstetrics and Gynecology at the Uniformed Services Residency at Walter Reed National Military Medical Center in Bethesda, Md. She then completed fellowship training in Maternal-Fetal Medicine at Johns Hopkins Hospital in Baltimore, Md. which was followed by 14 years of service in the U.S. Navy.

Much of her time in the Navy she was stationed at Walter Reed National Military Medical Center, where she served as Chief of Obstetrics and Director of the Maternal-Fetal Medicine Division as well as Associate Residency Program Director. Upon leaving the Navy, Dr. Driggers joined the faculty at MedStar Washington Hospital Center in Washington, DC, serving as the Program Director of the Maternal-Fetal Medicine Fellowship and Associate Professor of Obstetrics and Gynecology at Georgetown University School of Medicine.

Dr. Driggers is currently Associate Professor of Obstetrics and Gynecology at Johns Hopkins University School of Medicine and has served as the Medical Director of Maternal Fetal Medicine at Johns Hopkins Sibley Memorial Hospital for the past 10 years.

Disclosures

- Dr. Rita Driggers has no relevant financial or non-financial relationships to disclose relating to the content of this activity.
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Learning Objectives

At the completion of this presentation, participants will be able to:

1. Describe physiologic changes in pregnancy that affect the cardiovascular system.
2. Summarize risk factors for cardiovascular and hypertensive disease in pregnancy.
3. Discuss signs and symptoms of cardiovascular and hypertensive disease in pregnancy.
4. Outline the most common presentations of cardiovascular disease in pregnancy.
5. Explain general management of chronic hypertension, preeclampsia, and cardiovascular disease in pregnancy.

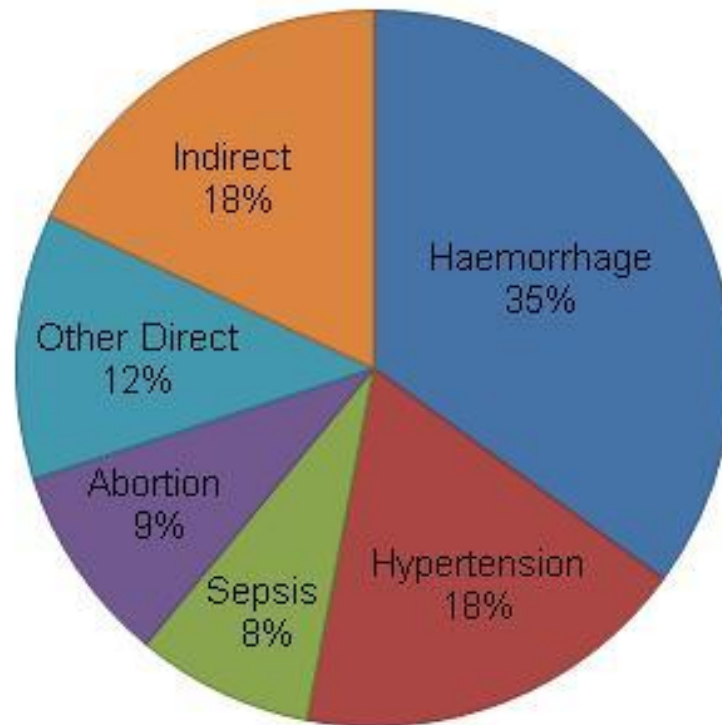
Impact/Prevalence (1 of 7)

- Cardiovascular disease
 - Disease/dysfunction of heart and vascular system
 - Affects 1-4% of US pregnancies
 - Leading cause of death during pregnancy and postpartum period in US
 - Rising trend in maternal deaths due to acquired heart disease

(ACOG, 2019)

Impact/Prevalence (2 of 7)

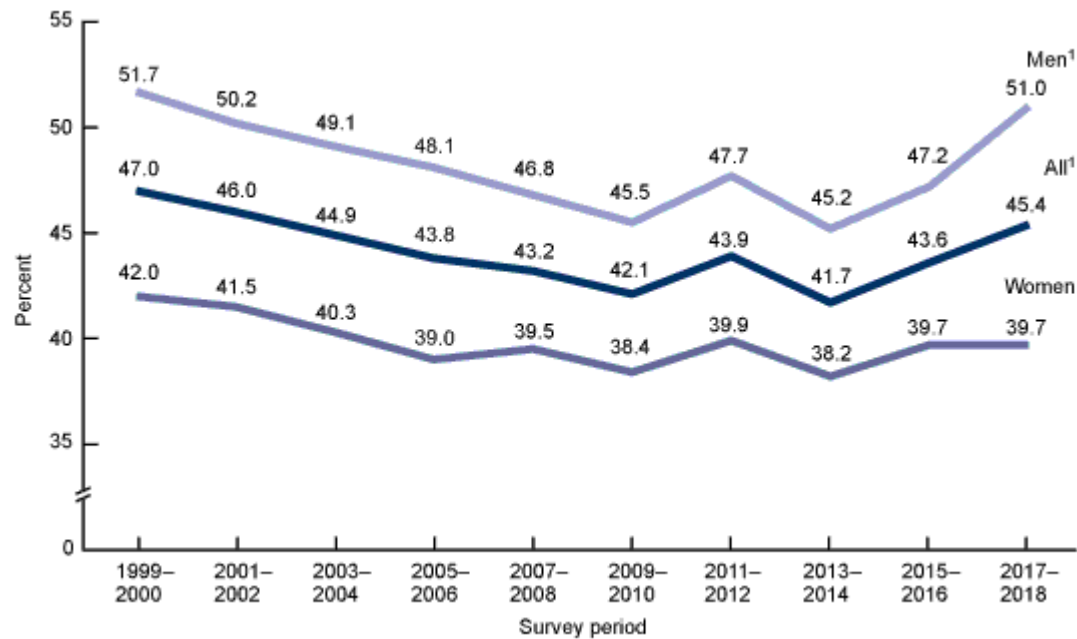
Direct Causes of Maternal Mortality



Source: Countdown to 2015 Decade Report (2000-2010), World Health Organization (2010)

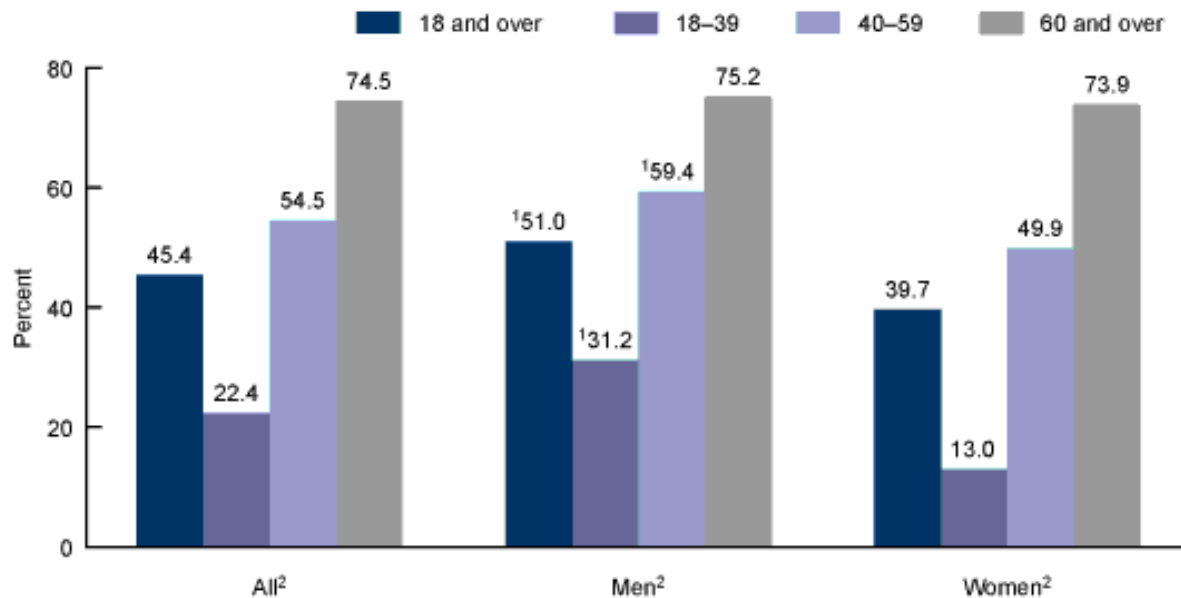
Impact/Prevalence (3 of 7)

- Age-adjusted trend in hypertension prevalence among adults aged 18 and over, by sex: United States, 1999 -2018



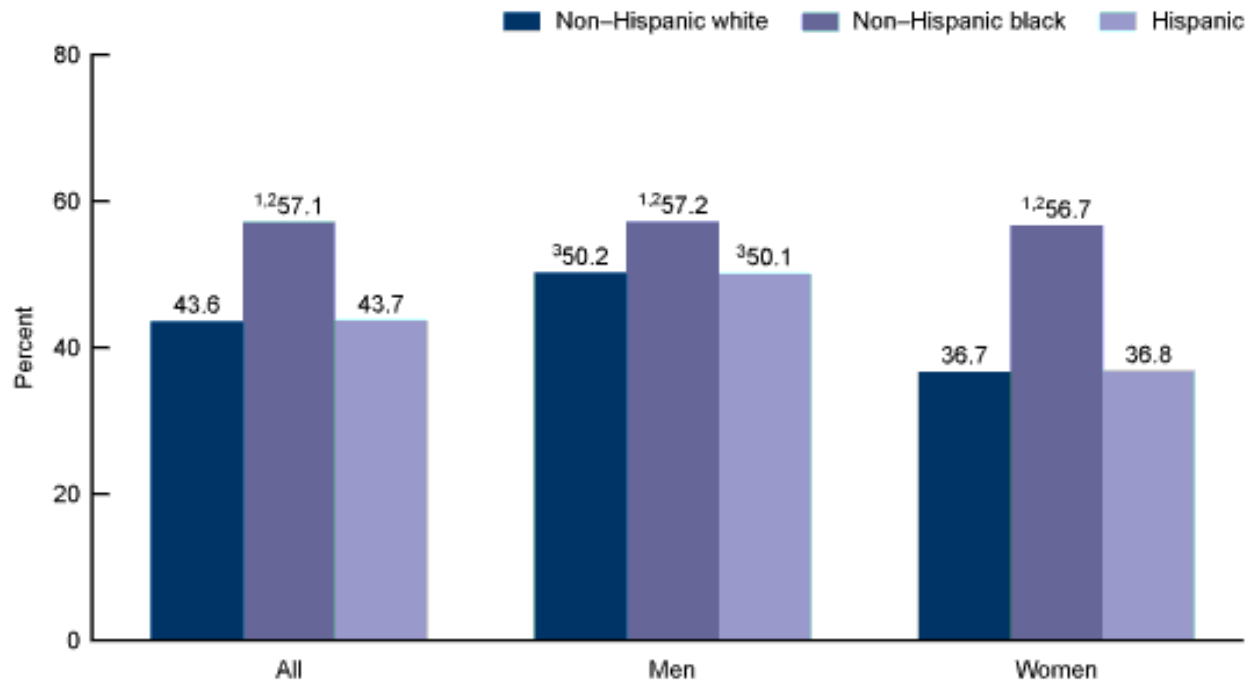
Impact/Prevalence (4 of 7)

- Prevalence of hypertension among adults aged 18 and over, by sex and age: United States, 2017-2018



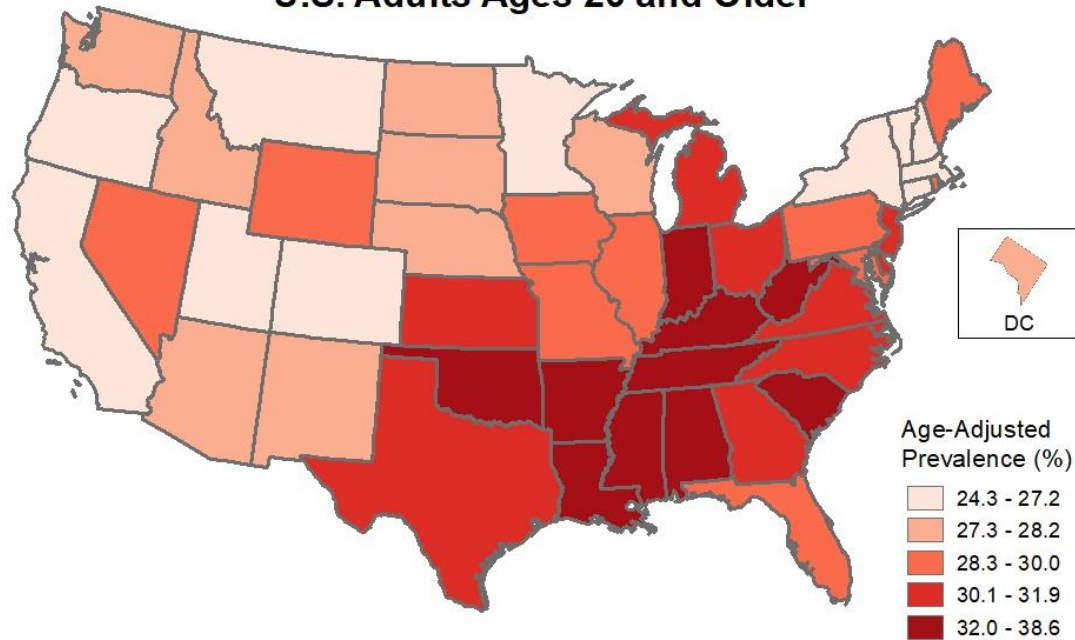
Impact/Prevalence (5 of 7)

- Age-adjusted prevalence of hypertension among adults aged 18 and over, by race and Hispanic origin: United States, 2017-2018



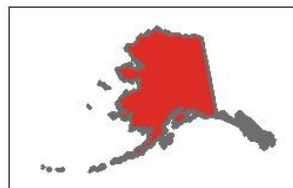
Impact/Prevalence (6 of 7)

Prevalence of Hypertension, 2017 U.S. Adults Ages 20 and Older



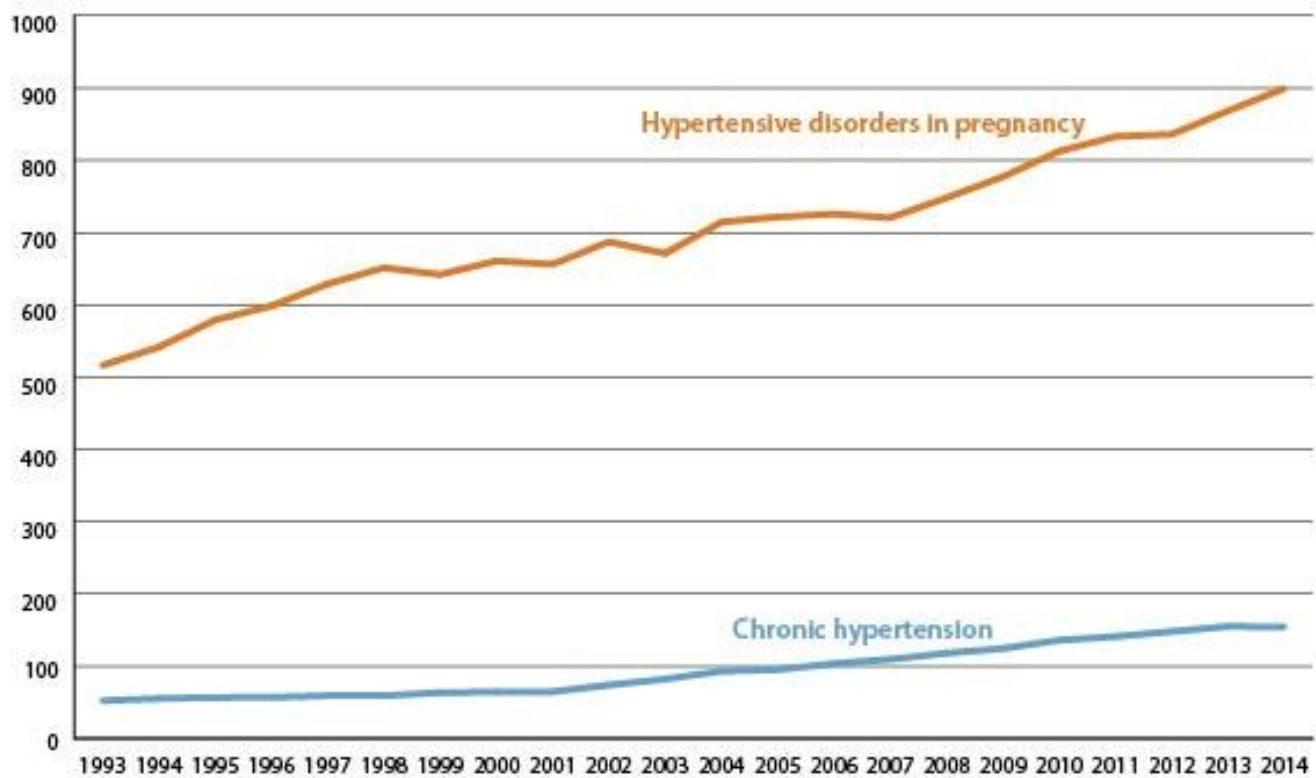
Data Source:
BRFSS - Behavioral Risk Factor Surveillance System, CDC.

Self-report: "Have you ever been told by a doctor, nurse, or other health care professional that you have high blood pressure?" Excludes women who reported being told only during pregnancy and respondents who reported they had been told that their blood pressure was borderline high or pre-hypertensive.



Impact/Prevalence (7 of 7)

Rate of hypertensive disorders per 10,000 delivery hospitalizations



Risk Factors for Chronic Hypertension

- Age
- Sex
- Race/ethnicity
- Diabetes
- Unhealthy diet
- Physical inactivity
- Too much alcohol
- Tobacco use
- Genetics and family history

Risk Factors for Cardiovascular Disease

- Race/ethnicity
 - Non-Hispanic black women have 3.4x higher risk of dying from cardiovascular disease-related pregnancy complications compared with non-Hispanic white women
 - Independent of other variables
- Age
 - Age > 40 years increases risk of heart disease-related maternal death 30x risk for < 20 years
- Hypertension
 - Incidence of myocardial infarction and heart failure is 13-fold and 8-fold higher, respectively
- Obesity

Risk Factors for Cardiovascular Disease, continued

- Hypertensive disorders of pregnancy
 - Preeclampsia
 - Eclampsia
 - Hemolysis, elevated liver enzymes, low platelets (HELLP)
- Chronic disease
- Obstructive sleep apnea
- History of preterm delivery
- Strong family history of heart disease
- Exposure to cardiotoxic drugs

Social Determinants of Disparities

- Racial and ethnic bias in provision of health care and health system processes
 - Physician implicit and explicit bias and overt racism
 - Health system barriers to efficient triage
 - Patient mistrust of medical system
 - Higher rate of obesity in racial/ethnic nonwhite groups

Cardiovascular Physiologic Changes in Pregnancy

Table 1. Cardiovascular Changes in a Normal Pregnancy*

	First Trimester	Second Trimester	Third Trimester	Stage 1 Labor	Stage 2 Labor	Early Postpartum	3–6 months Postpartum
Cardiac output	↑5–10%	↑↑35–45%		↑30%	↑↑50%	↑↑↑60–80% immediately, then rapidly decreases within the first hour	Return to prepregnancy values
Heart rate	↑3–5%	↑10–15%	↑15–20%	During uterine contractions: ↑40–50%		↓5–10% within 24 hours; continues to decrease throughout the first 6 weeks	Return to prepregnancy values
Blood pressure	↓10%	↓5%	↑5%	During uterine contractions: ↑SBP 15–25% ↑DBP 10–15%		↓SBP 5–10% within 48 hours; may increase again between days 3–6 due to fluid shifts	Return to prepregnancy values
Plasma volume	↑	↑↑40–50%		↑	↑↑	↑↑↑500 mL due to autotransfusion	Return to prepregnancy values

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure.

*Hemodynamic changes that occur during pregnancy, labor, and postpartum (compared with prepregnancy) should be understood to identify early interventions (such as blood pressure control and diuresis) that may be needed to prevent clinical deterioration in a woman with cardiovascular disease.

Data from Kuhn JC, Falk RS, Langesaeter E. Haemodynamic changes during labour: continuous minimally invasive monitoring in 20 healthy parturients. *Int J Obstet Anesth* 2017;31:74–83; Ouzounian JG, Elkayam U. Physiologic changes during normal pregnancy and delivery. *Cardiol Clin* 2012;30:317–29; Sanghavi M, Rutherford JD. Cardiovascular physiology of pregnancy. *Circulation* 2014;130:1003–8; Shen M, Tan H, Zhou S, Smith GN, Walker MC, Wen SW. Trajectory of blood pressure change during pregnancy and the role of pre-gravid blood pressure: a functional data analysis approach. *Sci Rep* 2017;7:6227; Sohnchen N, Melzer K, Tejada BM, Jastrow-Meyer N, Othenin-Girard V, Irion O, et al. Maternal heart rate changes during labour. *Eur J Obstet Gynecol Reprod Biol* 2011;158:173–8; and Walters BN, Walters T. Hypertension in the puerperium [letter]. *Lancet* 1987;2:330.

Presentation of Cardiovascular Disease

- Most common presentation of acquired heart disease during pregnancy and postpartum
 - Heart failure
 - Myocardial infarction
 - Arrhythmia
 - Aortic dissection
- Diagnosis challenging
 - Overlapping symptoms with normal pregnancy

Table 2. How to Differentiate Common Signs and Symptoms of Normal Pregnancy Versus Those That Are Abnormal and Indicative of Underlying Cardiac Disease

	ROUTINE CARE	CAUTION*†	STOP†‡
	Reassurance	Nonemergent Evaluation	Prompt Evaluation Pregnancy Heart Team
History of CVD	None	None	Yes
Self-reported symptoms	None or mild	Yes	Yes
Shortness of breath	No interference with activities of daily living; with heavy exertion only	With moderate exertion, new-onset asthma, persistent cough, or moderate or severe OSA§	At rest; paroxysmal nocturnal dyspnea or orthopnea; bilateral chest infiltrates on CXR or refractory pneumonia
Chest pain	Reflux related that resolves with treatment	Atypical	At rest or with minimal exertion
Palpitations	Few seconds, self-limited	Brief, self-limited episodes; no lightheadedness or syncope	Associated with near syncope
Syncope	Dizziness only with prolonged standing or dehydration	Vasovagal	Exertional or unprovoked
Fatigue	Mild	Mild or moderate	Extreme
Vital signs	Normal		
HR (beats per minute)	<90	90–119	≥120
Systolic BP (mm Hg)	120–139	140–159	≥160 (or symptomatic low BP)
RR (per minute)	12–15	16–25	≥25
Oxygen saturation	>97%	95–97%	<95% (unless chronic)
Physical examination	Normal		
JVP	Not visible	Not visible	Visible >2 cm above clavicle
Heart	S3, barely audible soft systolic murmur	S3, systolic murmur	Loud systolic murmur, diastolic murmur, S4
Lungs	Clear	Clear	Wheezing, crackles, effusion
Edema	Mild	Moderate	Marked

Abbreviations: BP, blood pressure; CVD, cardiovascular disease; CXR, chest x-ray; HR, heart rate; JVP, jugular venous pressure; OSA, obstructive sleep apnea; RR, respiratory rate.

*If unclear, any combination of factors in the yellow column that add up to 4 or more should prompt further evaluation.

†Data in this column from Afshan B. Hameed, Christine H. Morton, and Allana Moore. Improving Health Care Response to Cardiovascular Disease in Pregnancy and Postpartum. Developed under contract #11-10006 with the California Department of Public Health, Maternal, Child and Adolescent Health Division. Published by the California Department of Public Health, 2017. Available at <https://www.cmqcc.org/resources-toolkits/toolkits/improving-health-care-response-cardiovascular-disease-pregnancy-and>.

‡History of CVD or signs and symptoms in the red column should lead to urgent evaluation by the Pregnancy Heart Team.

§Should raise concern about heart failure and should promptly be evaluated.

Modified from Thorne S. Pregnancy and native heart valve disease. Heart 2016;102:1410–7.

Cardiovascular and Hypertensive Disease in Pregnancy

- Hypertensive disorders
- Presentation of acquired heart disease during pregnancy and postpartum period
 - Heart failure
 - Myocardial infarction
 - Arrhythmia
 - Aortic dissection

Chronic Hypertension



Chronic Hypertension, continued

- 2017 American College of Cardiology and the American Heart Association modified blood pressure categories:
 - Normal: Less than 120/80 mmHg
 - Elevated: Systolic between 120-129 *and* diastolic less than 80 mmHg
 - Stage 1: Systolic between 130-139 or diastolic between 80-89 mmHg
 - Stage 2: Systolic at least 140 or diastolic at least 90 mmHg
- Resulted in increase in prevalence of hypertension from ~32% to ~46% in the US adult population

Chronic Hypertension in Pregnancy

- Defined as hypertension diagnosed or present before pregnancy or before 20 weeks of gestation
- Hypertension diagnosed for first time during pregnancy and does not resolve in postpartum period
- Traditional blood pressure (BP) criteria:
 - Systolic BP of 140 mmHg or higher
 - Diastolic BP of 90 mmHg or higher
- Requires at least two readings at least four hours apart

Chronic Hypertension

Box 3. Historical Features Favoring Hypertension Cause

Primary Hypertension

- Gradual increase in BP, with slow rate of rise in BP
- Lifestyle factors that favor higher BP (eg, weight gain, high-sodium diet, decreased physical activity, job change entailing increased travel, excessive consumption of alcohol)
- Family history of hypertension

Secondary Hypertension

- BP lability, episodic pallor, and dizziness (pheochromocytoma)
- Snoring or hypersomnolence (obstructive sleep apnea)
- Muscle cramps or weakness (hypokalemia from primary aldosteronism or secondary aldosteronism due to renovascular disease)
- Weight loss, palpitations, heat intolerance (hyperthyroidism)
- Edema, fatigue, frequent urination (kidney disease or failure)
- History of coarctation repair (residual hypertension associated with coarctation)
- Central obesity, facial rounding, easy bruisability (Cushing syndrome)
- Medication or substance use (eg, alcohol, NSAIDs, cocaine, amphetamines)
- Absence of family history of hypertension

Abbreviations: BP, blood pressure; NSAIDs, nonsteroidal antiinflammatory drugs.

Reprinted from: Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, Dennison Himmelfarb C, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines [published erratum appears in J Am Coll Cardiol 2018;71:2275-9]. J Am Coll Cardiol 2018;71:e127-248.

Maternal Complications of Chronic Hypertension

- If poorly controlled:
 - Maternal mortality
 - Cerebrovascular accidents
 - Pulmonary edema
 - End-organ damage (heart, brain, kidneys)
- Gestational diabetes
- Superimposed preeclampsia
- Cesarean delivery
- Postpartum hemorrhage

Fetal/Neonatal Complications of Chronic Hypertension

- Stillbirth or perinatal death
 - Independent of other possible contributors
- Growth restriction (17%)
- Preterm birth (28%)
 - Indicated, not spontaneous
- Congenital anomalies
 - Cardiac, hypospadias, esophageal atresia
- Placental abruption

Management – Chronic Hypertension (1 of 4)

- Preconception
 - Evaluate for end-organ damage
 - Optimize maternal co-morbidities
 - Optimize blood pressure control
 - Medication review
 - Explain maternal and fetal/neonatal risks
 - Evaluate for causes of secondary hypertension

Management – Chronic Hypertension

(2 of 4)

- Baseline evaluation
 - Serum aspartate aminotransferase and alanine aminotransferase
 - Serum creatinine
 - Serum electrolytes (specifically potassium)
 - Blood urea nitrogen
 - Complete blood count
 - Spot urine protein/creatinine ratio or 24-hour urine for total protein and creatinine
 - Electrocardiogram or echocardiogram as appropriate
- Usual BP changes in pregnancy
- Low-dose aspirin (81mg)

Management – Chronic Hypertension

(3 of 4)

- BP treatment goals during pregnancy
 - Studies evaluating tight versus less tight control of BPs
 - Tight control of hypertension
 - Conferred no benefit to the fetus
 - Had only marginal effects for the woman (reduced frequency of progression to severe hypertension)
- Initiate antihypertensive therapy for persistent chronic hypertension:
 - Systolic BP greater than or equal to 160mmHg
 - Diastolic BP greater than or equal to 110mmHg
- Treat at lower blood pressure thresholds with comorbidities

Management – Chronic Hypertension (4 of 4)

- BP treatment goals during pregnancy
 - Limited data on ideal BP
 - Lowering BP too much may compromise uteroplacental blood flow
 - Current recommendations:
 - Systolic BP at or above 120mmHg but less than 160mmHg
 - Diastolic BP at or above 80mmHg but less than 110mmHg
 - Lower BPs for women with comorbid conditions

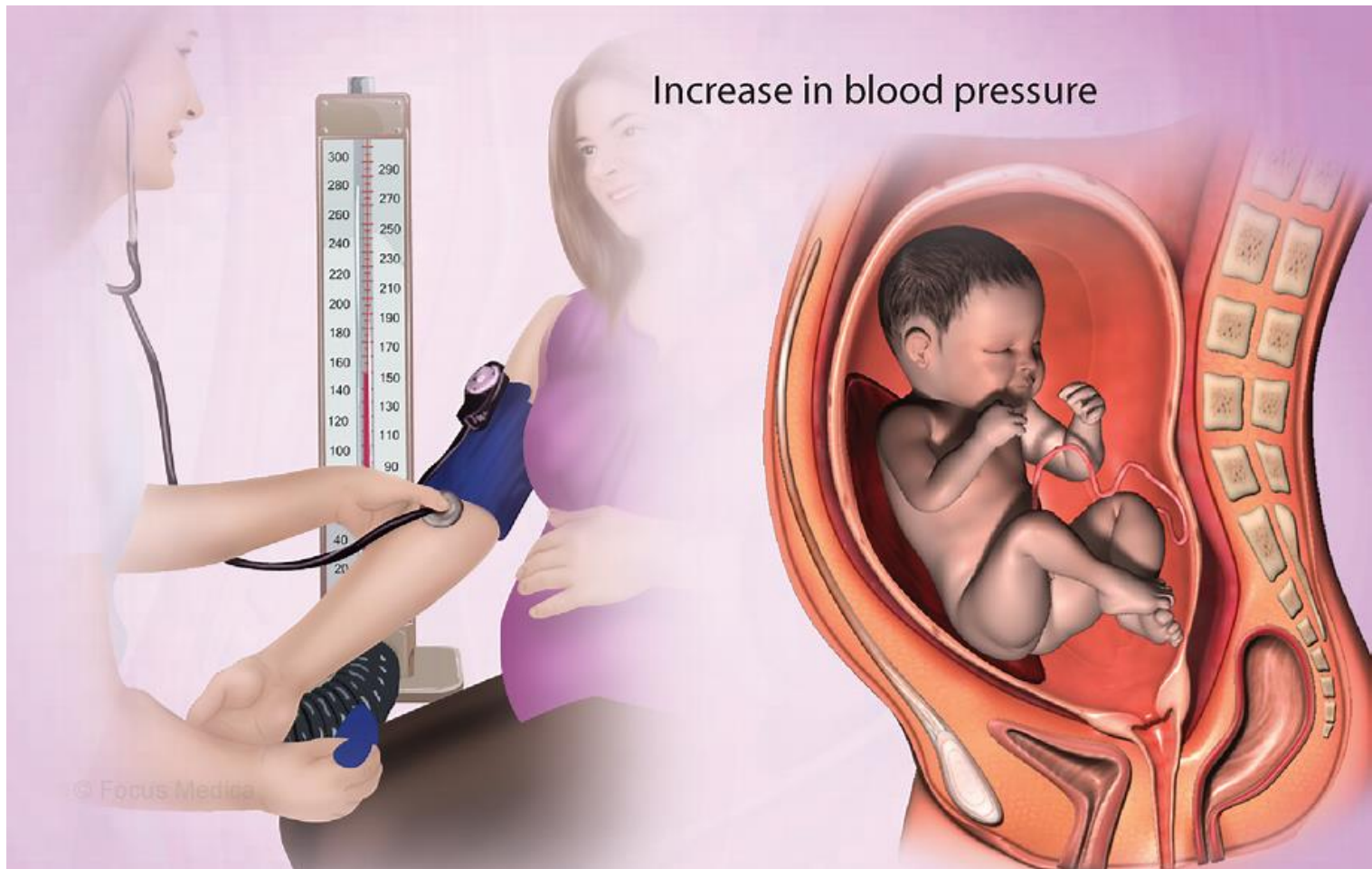
Management – Chronic Hypertension (CHTN)

- Maternal and fetal monitoring
 - Close monitoring of BPs
 - Assessment of fetal growth
 - Antenatal fetal surveillance
- Delivery timing
 - Delivery by 38+0-39+6 weeks with CHTN on no meds
 - Delivery by 37+0-39+6 weeks with CHTN controlled on meds
 - Delivery by 36+0-37+6 weeks with CHTN difficult to control
 - Delivery by 34 weeks or sooner with superimposed preeclampsia

Management – Chronic Hypertension

- Postpartum considerations
 - BP control continues to be an issue postpartum
 - After initial decline immediately after delivery, BPs rise
 - Severe hypertension or superimposed preeclampsia may develop
 - Outpatient follow up the first two weeks
 - Home BP monitoring
 - Goal BP postpartum:
 - Systolic BP \leq 150mmHg
 - Diastolic BP $<$ 100mmHg

Preeclampsia



(<https://www.msn.com/en-us/health/>, n.d.)

Preeclampsia, continued

- Systolic BP ≥ 140 mmHg or diastolic BP ≥ 90 mm Hg on two occasions at least four hours apart after 20 weeks in patient with a previously normal BP, and
- Proteinuria
 - 300 mg or higher on 24-hour urine collection
 - Protein:Creatinine ratio of 0.3 or more
 - Dipstick reading of 2+ protein
 - Gestational hypertension diagnosed in absence of proteinuria
- Preeclampsia may be diagnosed without proteinuria if severe features are present

Preeclampsia with Severe Features

- Systolic blood pressure of 160 mm Hg or higher, or diastolic blood pressure of 110 mm Hg or higher on two occasions at least four hours apart
- Thrombocytopenia: Platelet (Plt) less than 100k
- Renal insufficiency: Creatinine (Cr) greater than 1.1mg/dl or doubled
- Impaired liver function: Liver transaminases twice upper limits of normal or severe persistent right upper quadrant (RUQ) or epigastric pain
- Pulmonary edema
- Headache unresponsive to medication and not explained by alternative diagnosis
- Visual disturbances

HELLP Syndrome

- Hemolysis, elevated liver enzymes, and low platelets (HELLP) syndrome
 - More severe form of preeclampsia
 - Associated with increased rates of maternal morbidity and mortality
 - Suggested diagnostic criteria:
 - Aspartate transferase (AST) or alanine transaminase (ALT) more than twice upper limits of normal
 - Platelets < 100k
 - Lactate dehydrogenase (LDH) \geq 600 IU/L

Eclampsia

- Most severe manifestation of hypertensive disorders of pregnancy
- New-onset seizures in absence of other causes
- Significant cause of maternal mortality, especially in low-resource settings
- Occurs in small proportion of patients:
 - 1.9% with preeclampsia
 - 3.2% with severe features

Eclampsia, continued

- Often preceded by signs of cerebral irritation
 - Severe occipital or frontal headache
 - Blurred vision/photophobia
 - Altered mental status
- May occur before, during, or after labor
- Up to 38% do not have hypertension or proteinuria prior to seizure

Risk Factors for Preeclampsia

- Nulliparity
- Multifetal gestations
- Preeclampsia in a previous pregnancy
- Chronic hypertension
- Pregestational diabetes
- Gestational diabetes
- Thrombophilia
- Systemic Lupus Erythematosus (SLE)
- Prepregnancy Body Mass Index (BMI) > 30 kg/m²
- Antiphospholipid antibody syndrome
- Age 35 years or older
- Kidney disease
- Assisted reproductive technology
- Obstructive sleep apnea

Maternal Complications of Preeclampsia

- Progression to eclampsia
 - Seizures may lead to
 - Maternal hypoxia
 - Trauma
 - Aspiration pneumonia
 - Residual neurologic damage is rare
- Increased risk of chronic hypertension and cardiovascular disease

Fetal/neonatal Complications of Preeclampsia

- Fetal growth restriction
- Oligohydramnios
- Placental abruption
- Non-reassuring fetal heart rate monitoring
- Preterm birth
 - Spontaneous or indicated

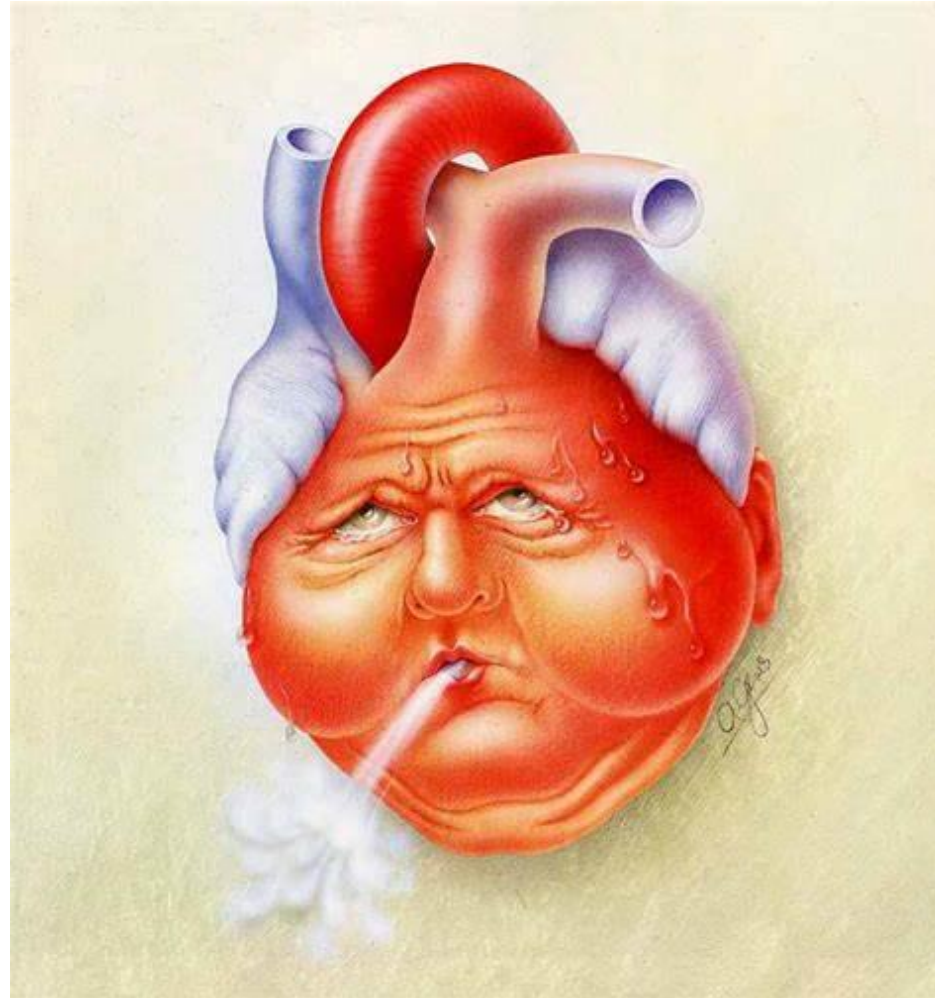
Management – Gestational Hypertension (GHTN) or Preeclampsia

- Delivery is the only cure for GHTN or preeclampsia
- Delaying delivery increases likelihood that preeclampsia will progress (to severe preeclampsia, HELLP, or eclampsia)
- Initial evaluation:
 - Labs (Complete blood count [CBC], Cr, LDH, AST, ALT, testing for proteinuria)
 - Ultrasound for estimated fetal weight and amniotic fluid index
 - Fetal monitoring
- Subsequent management depends on gestational age and test results
 - Must balance maternal and fetal risks

Management – Gestational Hypertension or Preeclampsia

- **Mild preeclampsia or GHTN ≥ 37 weeks**
 - Delivery is recommended
- **Mild preeclampsia or GHTN < 37 weeks**
 - Close monitoring
 - Delivery at 37 weeks
- **Severe preeclampsia or GHTN ≥ 34 weeks**
 - Delivery is recommended after maternal stabilization
 - Administration of intrapartum-postpartum magnesium sulfate to prevent eclampsia is recommended
- **Severe preeclampsia or GHTN < 34 weeks**
 - If stable maternal and fetal conditions, expectant management with close observation is recommended

Heart Failure



Heart Failure, continued

- Symptoms
 - Dyspnea
 - Orthopnea
 - Tachypnea
 - Asthma unresponsive to therapy

Heart Failure Risk Factors

- Hypertension
- Hypertensive disorders of pregnancy
- Cardiomyopathy
 - Peripartum
 - Pre-existing dilated
- Coronary artery disease
- Valvular heart disease
- Diabetes
- Obesity

Myocardial Infarction (1 of 3)



(<https://www.cedars-sinai.org/blog/heart-attacks-women-flying-radar.html>, 2018)

Myocardial Infarction (2 of 3)

- Complicates eight per 100,000 hospitalizations
- Maternal death in 5-11%
 - Highest risk in peripartum period
 - Higher than age-matched non-pregnant
- Physiologic changes of pregnancy favor development of or unmask underlying coronary artery disease

Myocardial Infarction (3 of 3)

- Symptoms
 - Chest pain
 - Shortness of breath
 - Vomiting
 - Reflux
 - Diaphoresis
 - Hemodynamic compromise
 - Arrhythmia
 - Cardiogenic shock

Myocardial Infarction Risk Factors

- Maternal age more than 30 years
- Non-Hispanic black race
- Elevated body mass index
- Diabetes mellitus
- Tobacco use
- Hyperlipidemia
- Strong family history of cardiovascular disease
- Hypertensive disorders of pregnancy
- History of coronary artery dissection
- Blood transfusion
- Peripartum infection

Arrhythmias (1 of 3)



(<https://ecg-educator.blogspot.com/2016/02/atrial-rhythms.html>, 2016)

Arrhythmias (2 of 3)

- Most common
 - Premature atrial beats
 - Paroxysmal supraventricular tachycardia
 - Atrial fibrillation
 - Atrial flutter
- Ventricular arrhythmias rare

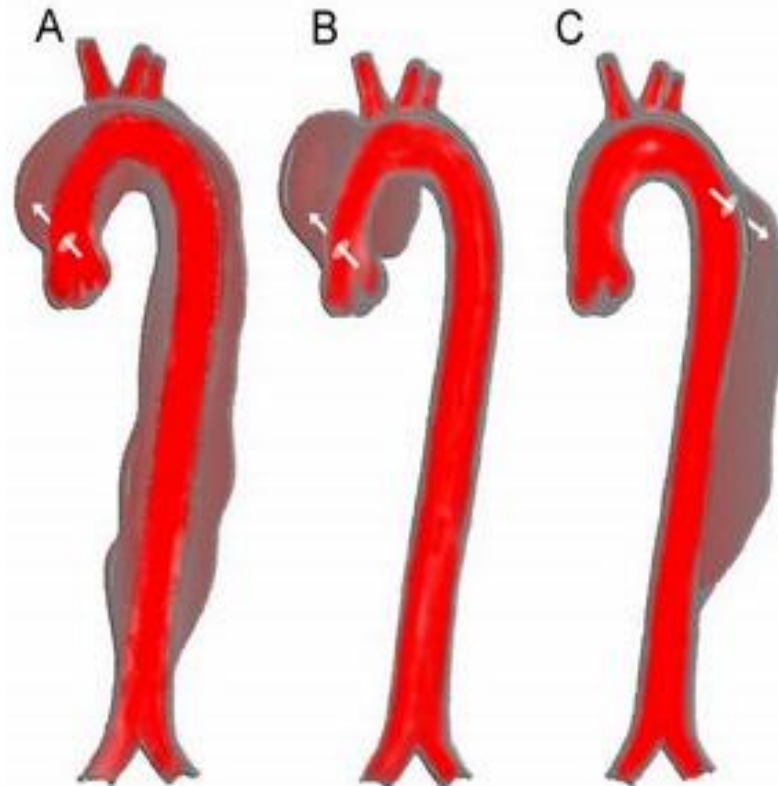
Arrhythmias (3 of 3)

- Symptoms
 - None
 - Fluttering in chest/palpitations
 - Chest pain
 - Dizziness, faintness, lightheadedness
 - Shortness of breath

Arrhythmia Risk Factors

- Coronary artery disease
- Hypertension
- Congenital heart defect
- Thyroid disease
- Obstructive sleep apnea
- Electrolyte imbalances
- Medications
- Excessive ethyl alcohol (ETOH) or caffeine
- Illicit drug use or drug misuse
- Genetics
- Smoking
- Stress or anxiety

Aortic Dissection (1 of 3)



DeBakey Type I

DeBakey Type II

DeBakey Type III

Stanford Type A

Stanford Type B

(<https://aorta.thecommonvein.net/dissection/>, 2012)

Aortic Dissection (2 of 3)

- Causes
 - Familial
 - Syndromic
 - Congenital
 - Inflammatory
- Most occur in ascending aorta
- No aortic dimension assures safe pregnancy
- Aorta replacement does not assure safe pregnancy

Aortic Dissection (3 of 3)

- Symptoms
 - Severe chest or upper back pain
 - Dizziness, fainting
 - Shortness of breath
 - Nausea
 - Loss of consciousness

Aortic Dissection Risk Factors

- Bicuspid aortic valve
- Hypertension
- Atherosclerosis
- Aneurysm
- Aortic coarctation
- Marfan syndrome
- Pregnancy
- Syphilis
- Age
- Blood vessel inflammation
- Connective tissue disease
- Genetic predisposition
- Heart surgery
- Smoking

Management of Cardiovascular Disease in Pregnancy

- Obtain baseline B-type natriuretic peptide (BNP)
- Standard troponin testing and electrocardiogram (ECG) for all pregnant and postpartum patients with chest pain
- Refer to center with appropriate maternal level of care

Key Takeaways

- Cardiovascular disease is leading cause of death during pregnancy and postpartum period in US
- Non-Hispanic black women are disproportionately affected by cardiovascular and hypertensive disease-related pregnancy complications
 - Structural, institutional, and systematic barriers
 - Contribute to higher rate of comorbidities
- Counseling patients about the complications and risks will empower patients to seek medical advice when appropriate

Key Takeaways, continued

- Symptoms of cardiovascular disease overlap with normal pregnancy symptoms
- Health care providers should become familiar with the signs and symptoms of cardiovascular disease as an important step toward improving maternal outcomes
- Referral to hospital setting with appropriate maternal level of care improves outcomes

Questions?



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