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Cardiovascular Disease and Pregnancy

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Outline

- Risk Stratification and Management Approach
- Cardiovascular Physiology during Pregnancy
- Epidemiology
- Rheumatic Heart Disease in Pregnancy
- Hypertension disorders of pregnancy
- Heart Failure in Pregnancy

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Risk stratification tools - ZAHARA

ZAHARA		
• Prior arrhythmia • NYHA III/IV • Left heart obstruction • Mechanical valve prosthesis (strongest weighed) • Cyanotic • Cardiac medication before pregnancy • Moderate/severe AVV regurgitation (systemic) • Moderate/severe AVV regurgitation (sub-pulmonary)	Arrhythmia – 1.5 Cardiac medication – 1.5 NYHA class – 0.75 Left heart obstruction – 2.5 Systemic AVVR – 0.75 Sub-pulmonary AVVR – 0.75 Mechanical valve – 4.25 Cyanosis – 1	>0.5 points – 2.9% 0.51–1.5 points – 7.5% 1.51–2.5 points – 17.5% 2.51–3.5 points – 43% >3.51 – 70%

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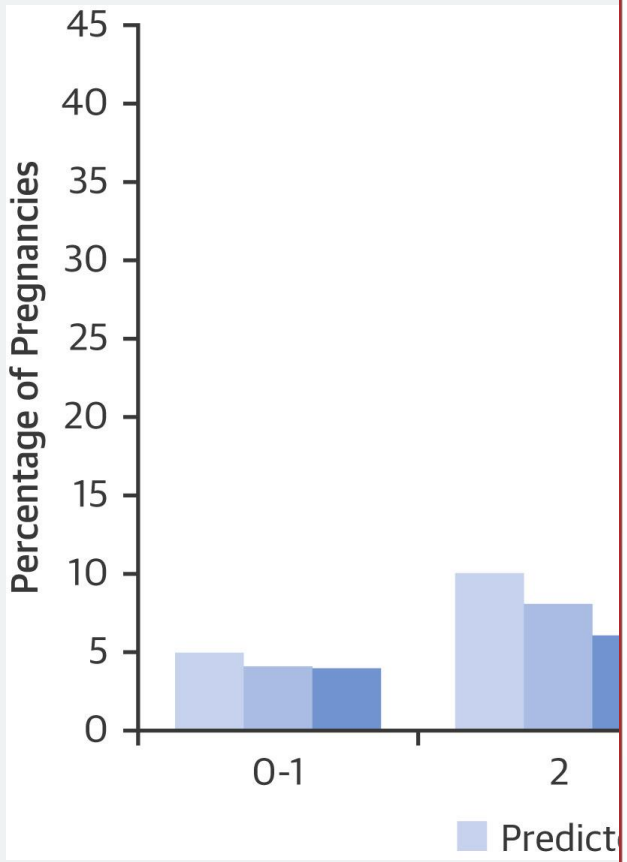
Kulasekaran, A et al. *US Cardiology Review* 2023: 17:e06

Risk stratificat



CENTRAL ILLUSTRATION: Predictors of Adverse Events in Pregnant Women With Heart Disease

Patient History
- Cardiac events prior to pregnancy
- Baseline NYHA functional class III/IV
- No cardiac interventions prior to pregnancy

Physical Exam
- Cyanosis (saturations <90% at rest)

Specific Lesions
- Mechanical valves
- Coronary artery disease
- High risk aortopathy

Imaging
- Systemic ventricular dysfunction
- High risk left-sided valve lesion or left ventricular outflow tract obstruction
- Pulmonary hypertension

Delivery of Care
- Late first antenatal visit

Other Variables
- Rare or understudied cardiac conditions
- Other maternal comorbidities (i.e., advanced maternal age, hypertension, obesity)
- Medications (i.e., anticoagulants)
- Other cardiac test results (cardiopulmonary testing or magnetic resonance imaging)
- Fertility therapy
- Patient compliance
- Patient access to care and quality of care

Silversides, C.K. et al. J Am Coll Cardiol. 2018;71(21):2419-30.

PREDICTOR	POINTS
ac events or arrhythmias	3
YHA III-IV or cyanosis	3
l valve	3
r dysfunction	2
eft-sided valve disease/ cular outflow tract obstruction	2
hypertension	2
rtery disease	2
ortopathy	2
rdiac intervention	1
nancy assessment	1

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Risk stratification tools – Modified WHO (mWHO)

Modified World Health Organization classification of maternal cardiovascular risk

	mWHO I	mWHO II	mWHO II–III	mWHO III	mWHO IV
Diagnosis (if otherwise well and uncomplicated)	Small or mild – pulmonary stenosis – patent ductus arteriosus – mitral valve prolapse Successfully repaired simple lesions (atrial or ventricular septal defect, patent ductus arteriosus, anomalous pulmonary venous drainage) Atrial or ventricular ectopic beats, isolated	Unoperated atrial or ventricular septal defect Repaired tetralogy of Fallot Most arrhythmias (supraventricular arrhythmias) Turner syndrome without aortic dilatation	Mild left ventricular impairment (EF >45%) Hypertrophic cardiomyopathy Native or tissue valve disease not considered WHO I or IV (mild mitral stenosis, moderate aortic stenosis) Marfan or other HTAD syndrome without aortic dilatation Aorta <45 mm in bicuspid aortic valve pathology Repaired coarctation Atrioventricular septal defect	Moderate left ventricular impairment (EF 30–45%) Previous peripartum cardiomyopathy without any residual left ventricular impairment Mechanical valve Systemic right ventricle with good or mildly decreased ventricular function Fontan circulation. If otherwise the patient is well and the cardiac condition uncomplicated Unrepaired cyanotic heart disease Other complex heart disease Moderate mitral stenosis Severe asymptomatic aortic stenosis Moderate aortic dilatation (40–45 mm in Marfan syndrome or other HTAD; 45–50 mm in bicuspid aortic valve, Turner syndrome ASI 20–25 mm/m^2, tetralogy of Fallot <50 mm) Ventricular tachycardia	Pulmonary arterial hypertension Severe systemic ventricular dysfunction (EF <30% or NYHA class III–IV) Previous peripartum cardiomyopathy with any residual left ventricular impairment Severe mitral stenosis Severe symptomatic aortic stenosis Systemic right ventricle with moderate or severely decreased ventricular function Severe aortic dilatation (>45 mm in Marfan syndrome or other HTAD, >50 mm in bicuspid aortic valve, Turner syndrome ASI >25 mm/m^2, tetralogy of Fallot >50 mm) Vascular Ehlers–Danlos Severe (re)coarctation Fontan with any complication
Risk	No detectable increased risk of maternal mortality and no/mild increased risk in morbidity	Small increased risk of maternal mortality or moderate increase in morbidity	Intermediate increased risk of maternal mortality or moderate to severe increase in morbidity	Significantly increased risk of maternal mortality or severe morbidity	Extremely high risk of maternal mortality or severe morbidity
Maternal cardiac event rate	2.5–5%	5.7–10.5%	10–19%	19–27%	40–100%
Counselling	Yes	Yes	Yes	Yes: expert counselling required	Yes: pregnancy contraindicated: if pregnancy occurs, termination should be discussed
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

ASI = aortic size index; EF = ejection fraction; HTAD = heritable thoracic aortic disease; mWHO = modified World Health Organization classification; NYHA = New York Heart Association; WHO = World Health Organization.

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Regitz-Zagrosek, V et al. *European Heart Journal* Volume 39, Issue 34, 07 September 2018, Pages 3165-3241

Multidisciplinary approach to management

Davis, M et al. *J Am Coll Cardiol*. 2021 Apr 13;77(14):1763–1777

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Cardiovascular Physiology of Pregnancy

- Goal to meet metabolic needs and maintain uteroplacental circulation
- Physiologic changes are reversed a few months after delivery
- Unmasking of previously silent disease

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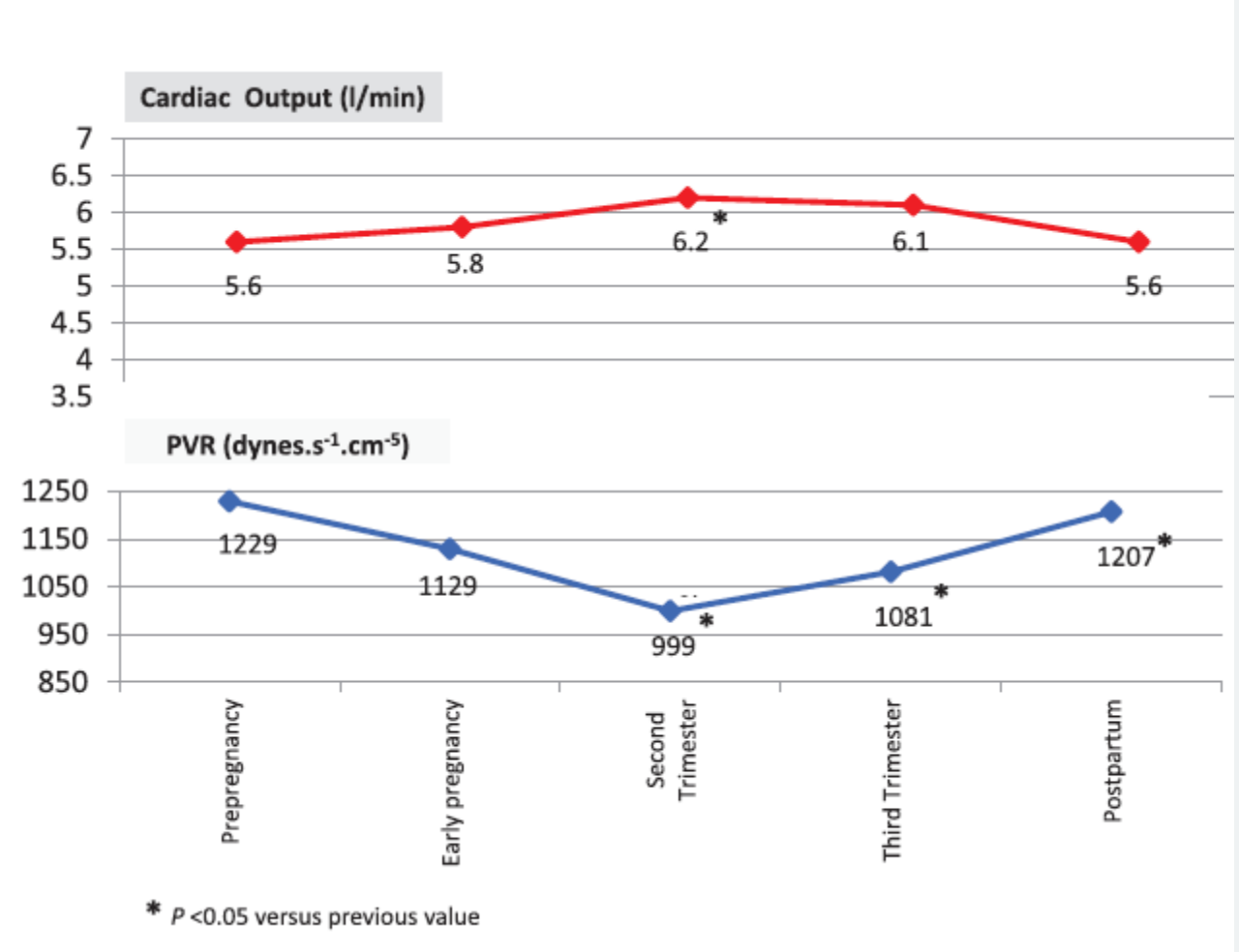
Cardiovascular Physiology of Pregnancy



- Systemic vasodilation occurs as early as 5 weeks
- Decrease in PVR nadirs 2nd trimester
- Normalizes early post-partum

- CO increases throughout pregnancy
- Mediated by increased SV early and increased HR

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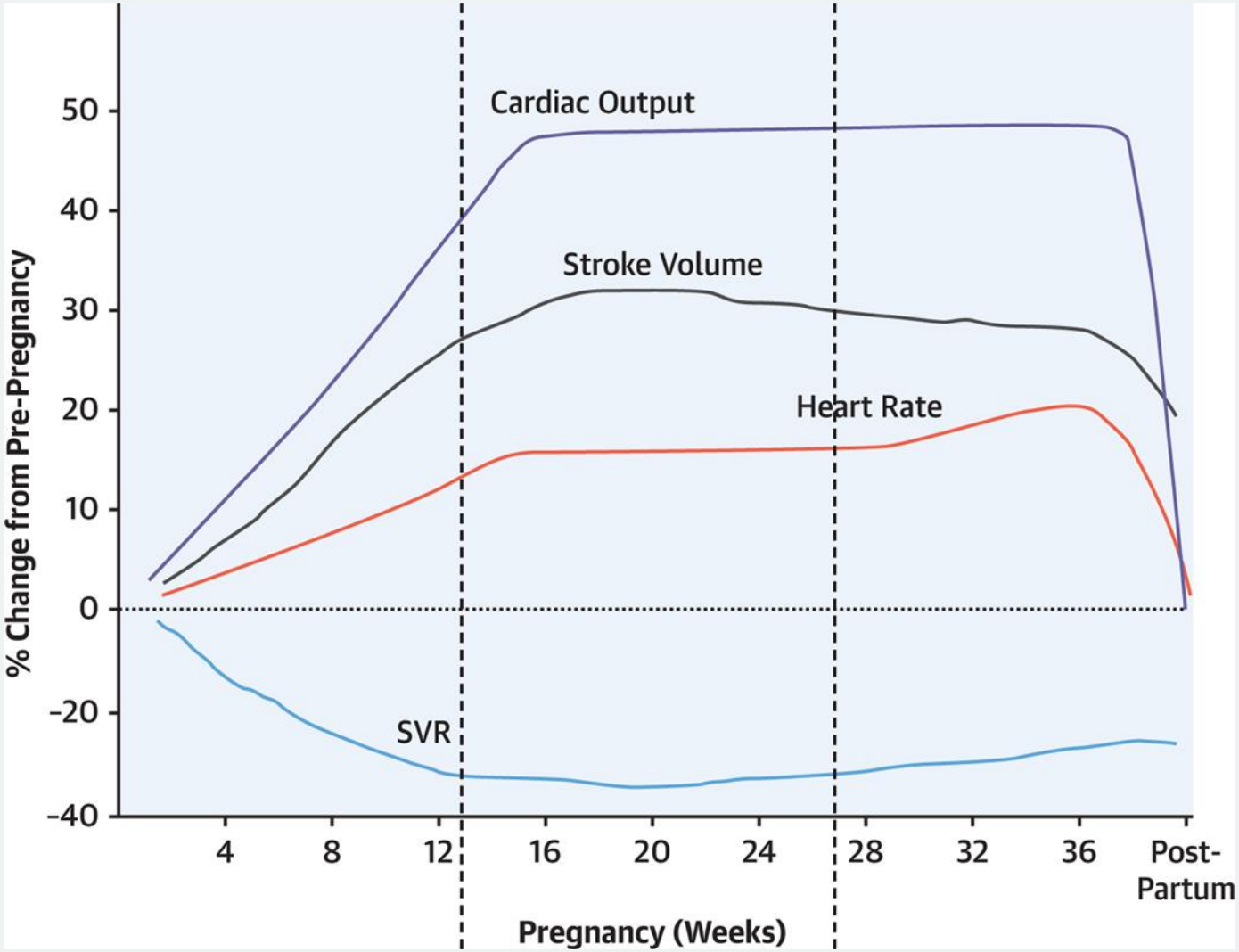
Sanghavi, M; Rutherford, J. *Circulation.* 2014;130:1003-1008

Cardiovascular Physiology of Pregnancy



Davis, M et al. *J Am Coll Cardiol*. 2021 Apr 13;77(14):1763–1777

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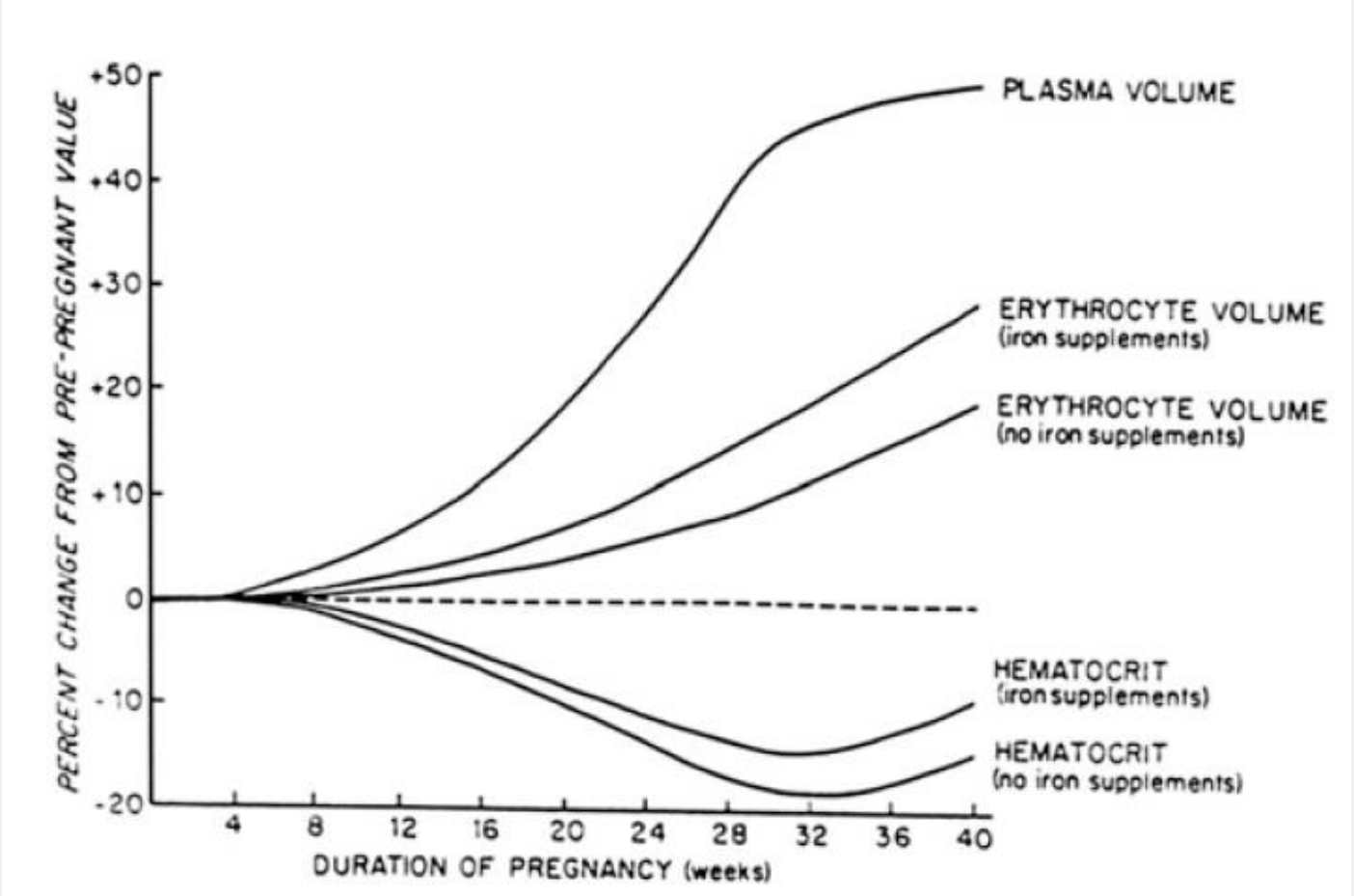
Cardiovascular Physiology of Pregnancy



Physiologic Anemia of Pregnancy

- Rapid increase in blood volume until mid pregnancy
- Almost double pre-pregnancy blood volume by 32 weeks
- Extracellular volume expansion
- Sodium retention
- Increase erythropoiesis does not match increase plasma volume

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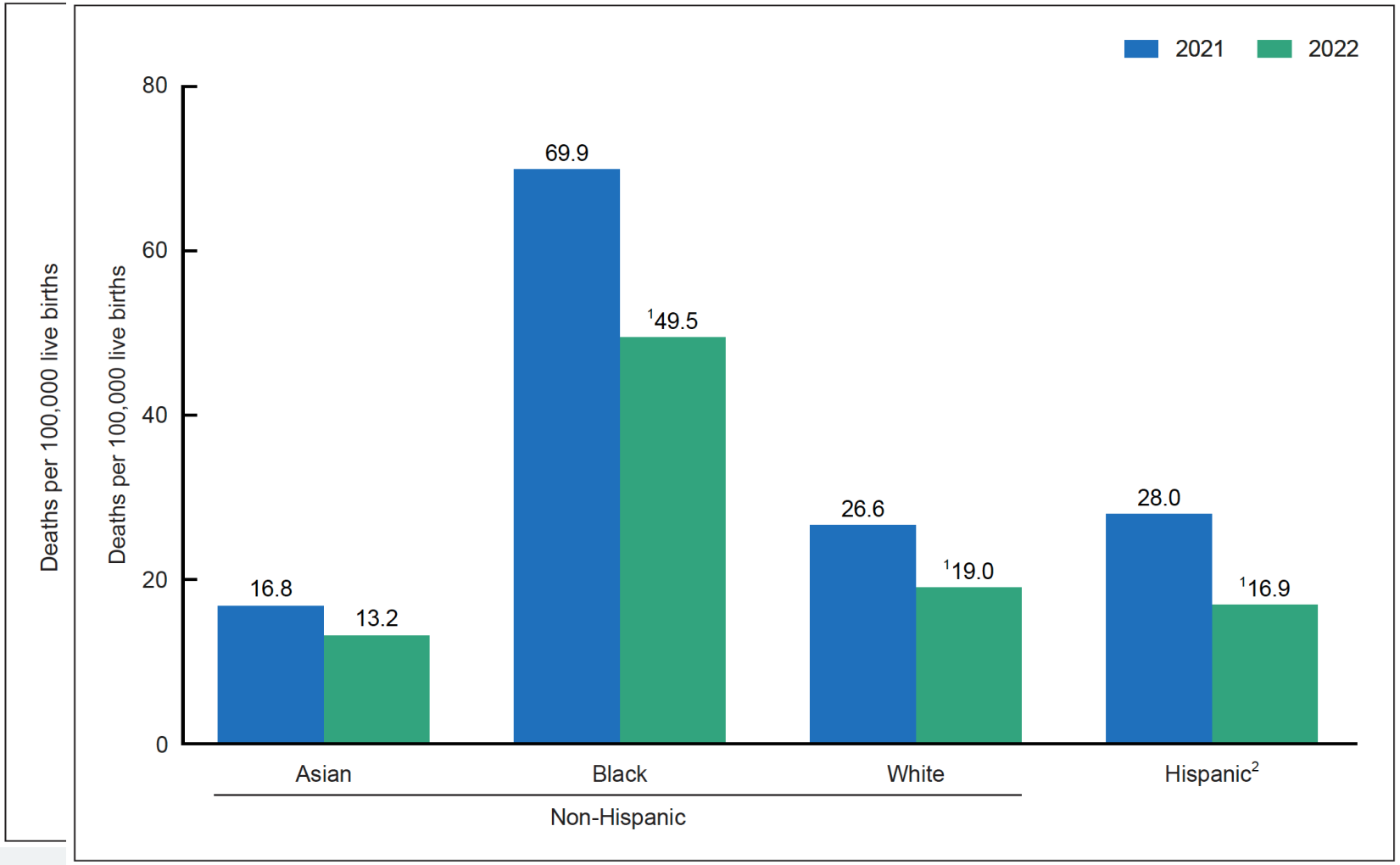
Ouzounian, J; Elkayam, U. *Cardiol Clin.* 30 (2012) 317-329

United States Data

Figur Figure 2. Maternal mortality rate, by race and Hispanic origin: United States, 2021 and 2022



Hoyert, DL. *National Center for Health Statistics.* Maternal Mortality Rates in the United States, 2021 and 2022 reports.

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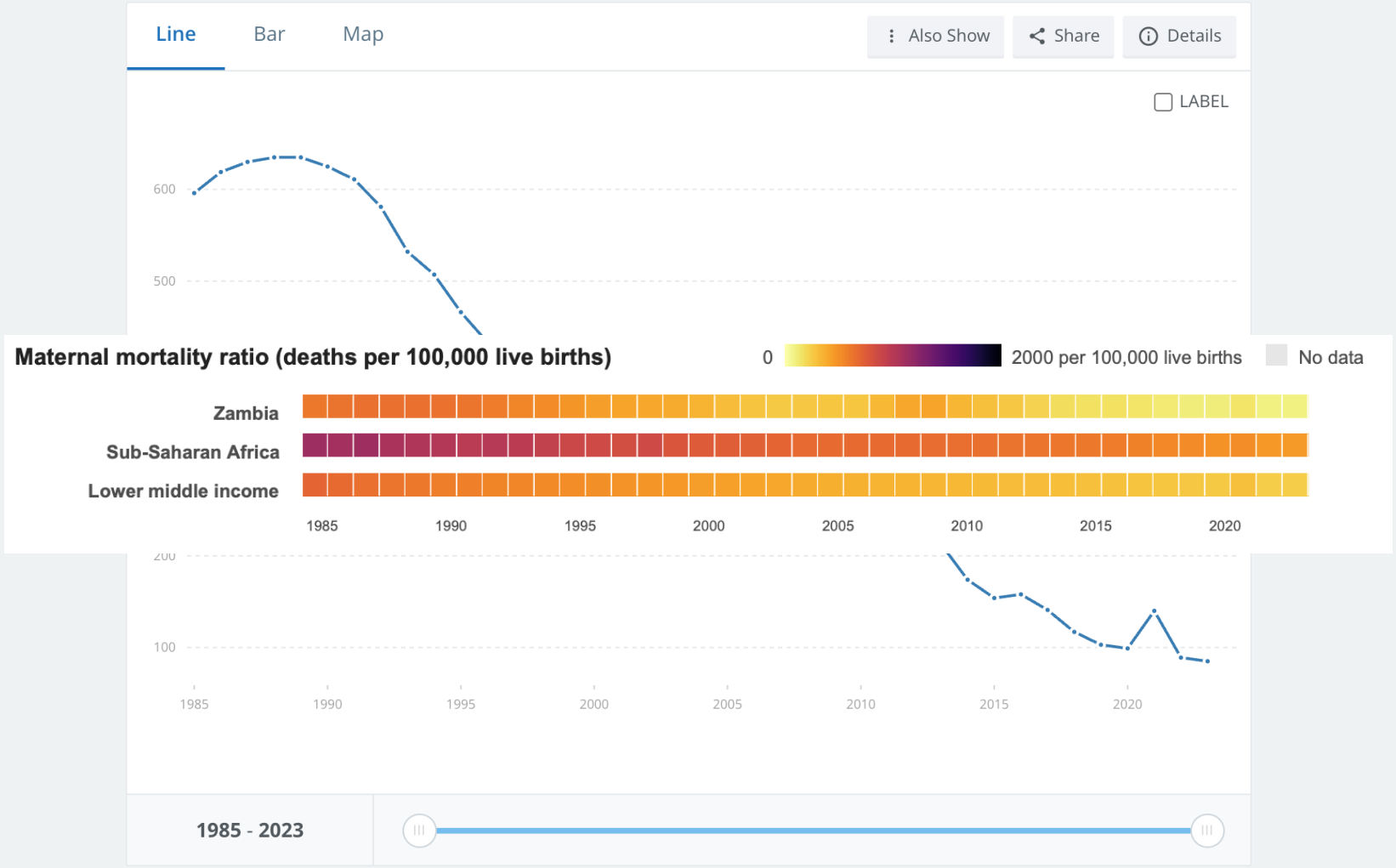
Zambia Data



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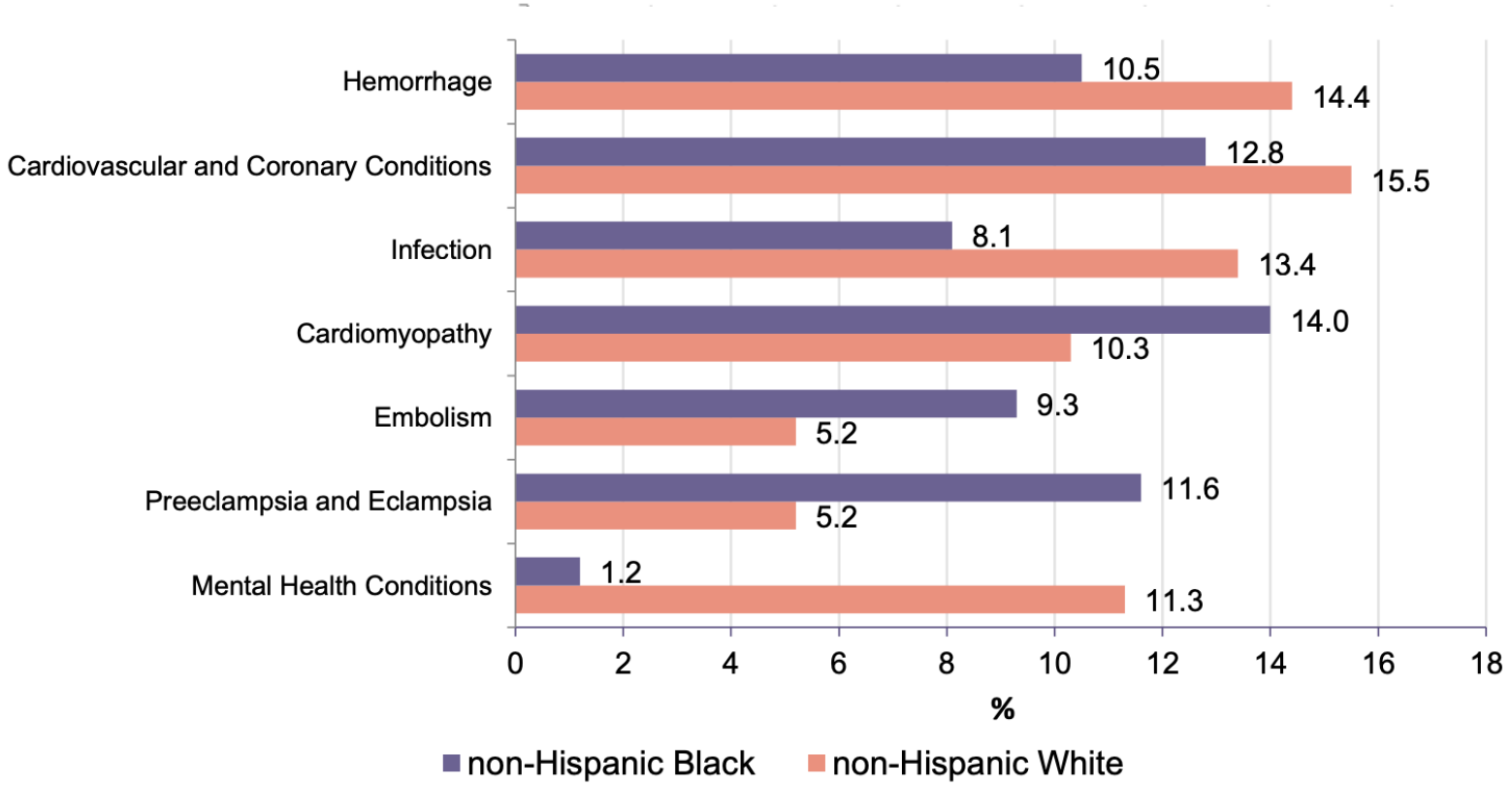
Trends in Maternal Mortality, World Health Organization (WHO), 2023

United States Causes of Mortality



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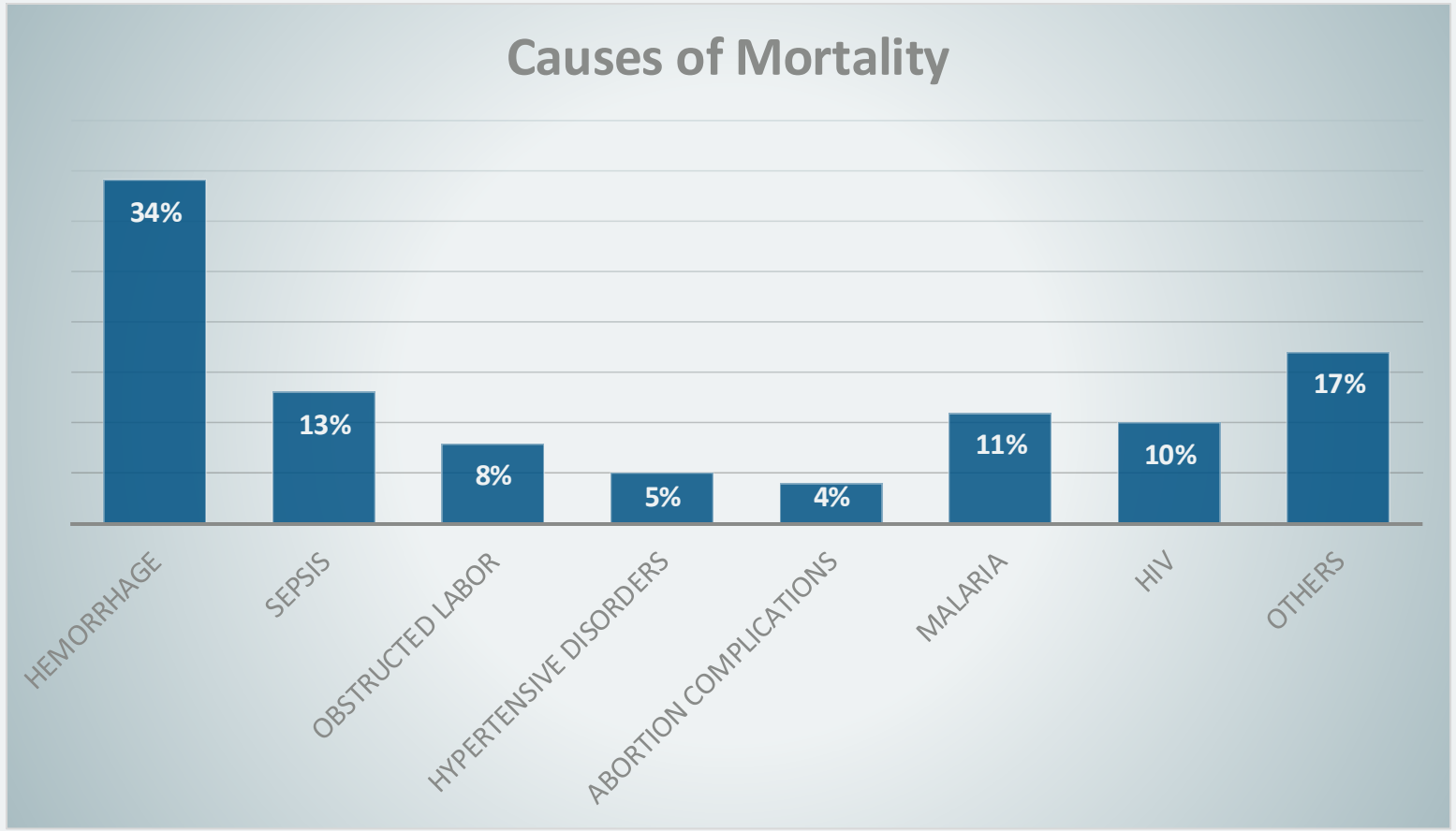
Zambia Causes of Mortality



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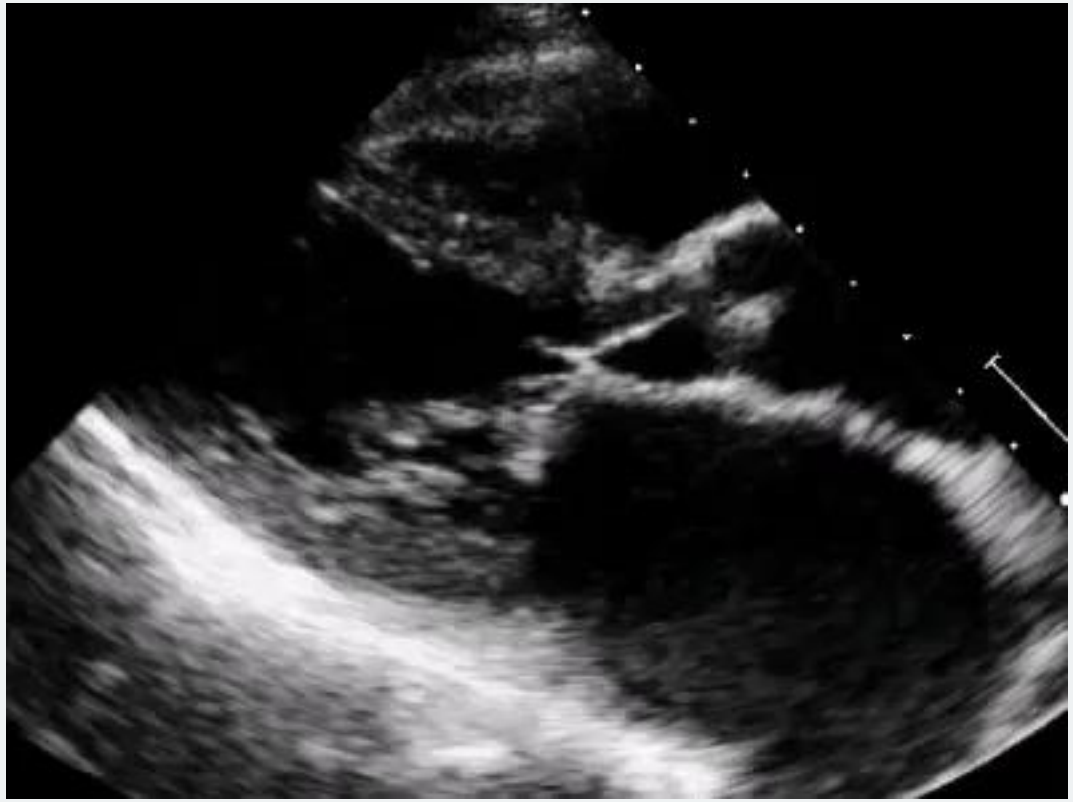
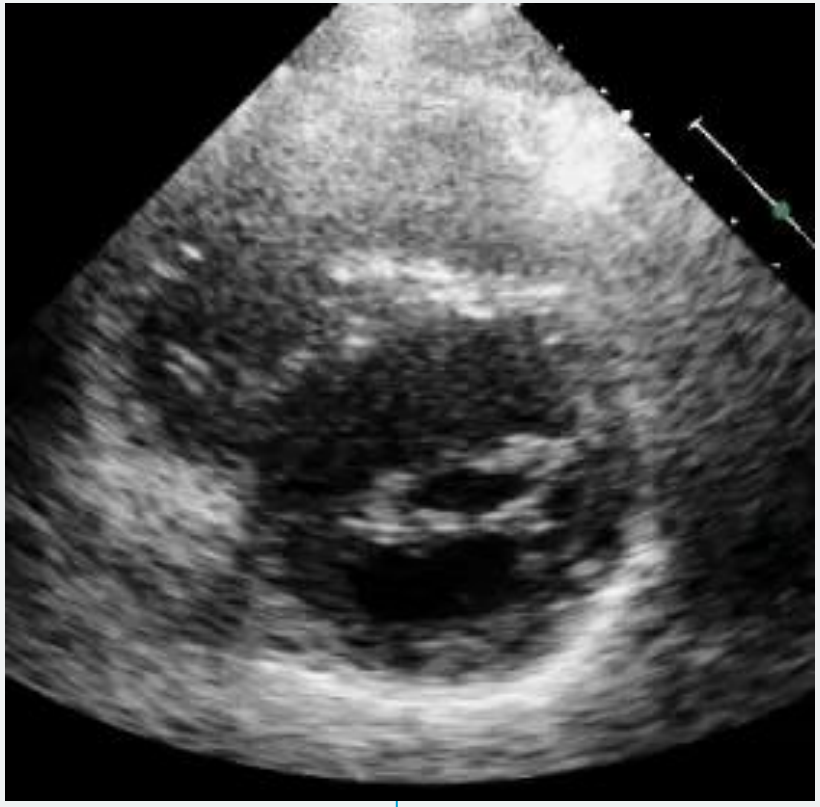
Status of Maternal Health in Zambia. Millenium Development Goals, 2013

Rheumatic Mitral Valve Stenosis





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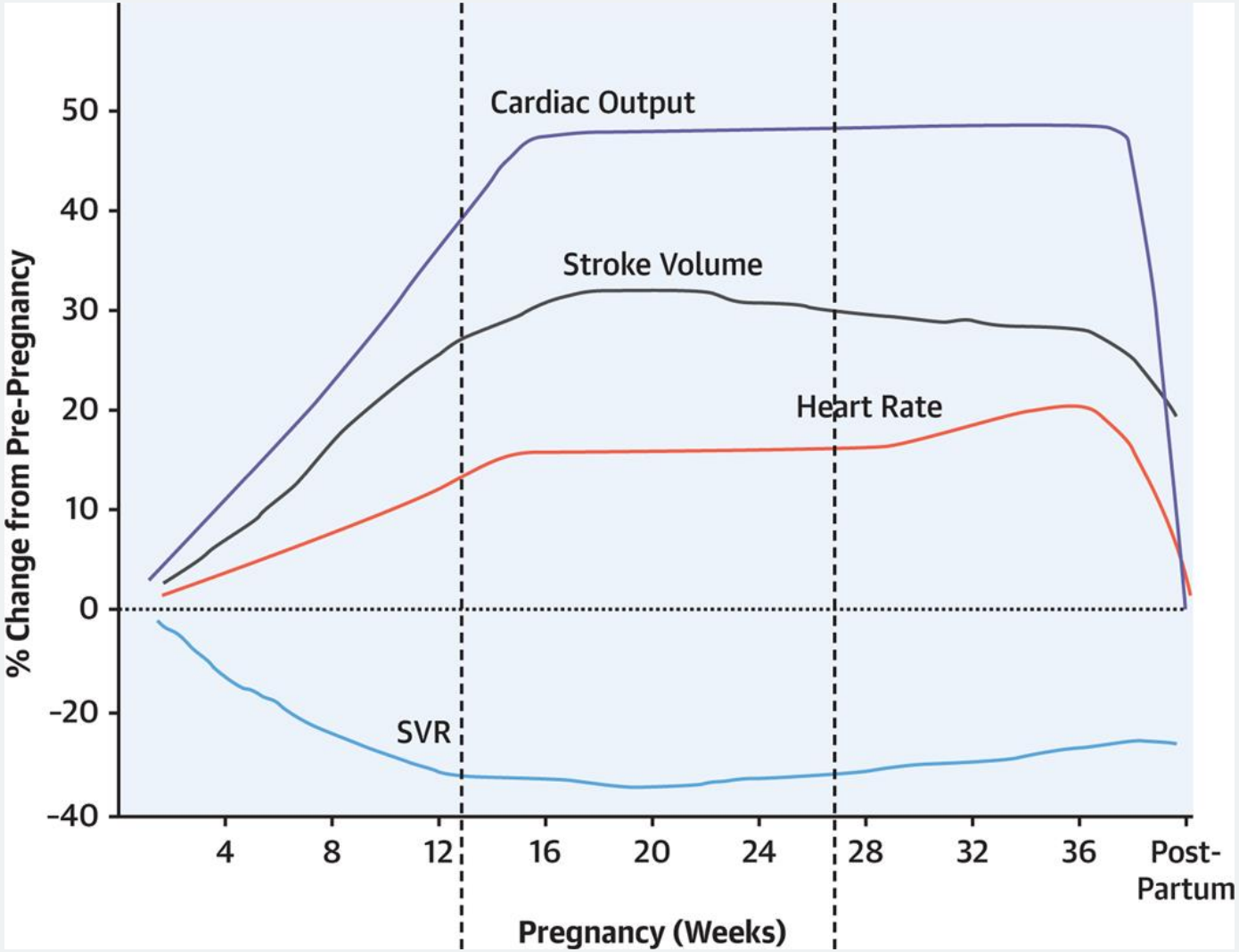
Cardiovascular Physiology of Pregnancy



Davis, M et al. *J Am Coll Cardiol*. 2021 Apr 13;77(14):1763–1777

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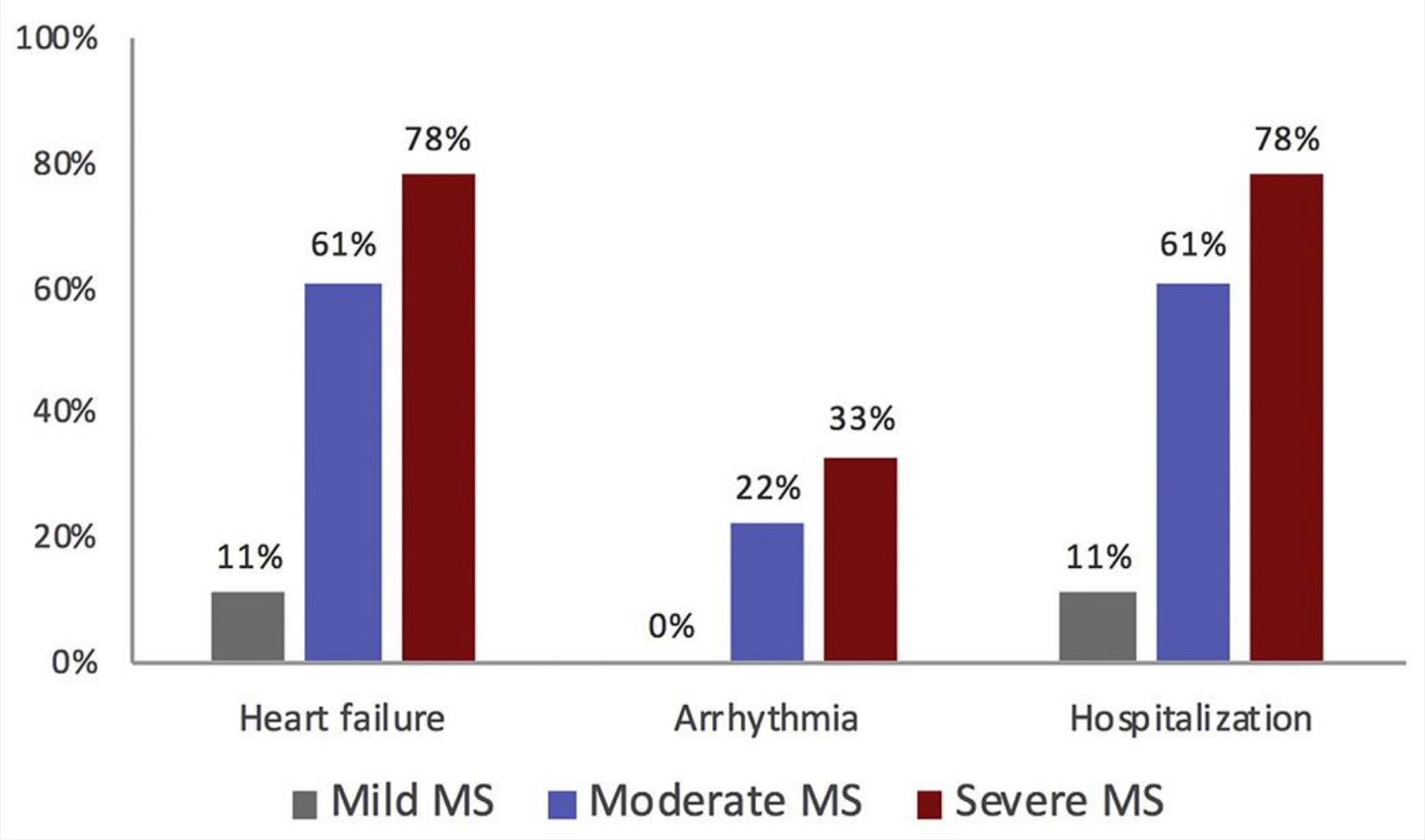
Mitral Stenosis Complications



- High risk: severe mitral or aortic stenosis
- MS is most common esp. in RHD prevalent regions
- MS associated with increased HF and arrhythmia risks

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Lewey, J et al. *Cardiol Clin.* 2021 Feb 39(1):151-161

Rheumatic Mitral Valve Stenosis – Management Strategy

- Beta blocker – slows HR and increases diastolic filling time
- Diuresis – remember the fetus!
- Anticoagulation for AF
- Management of AF – rate control, rhythm control, Digoxin
- Percutaneous or surgical intervention (2nd trimester if possible)
- Vaginal delivery with regional anesthesia (epidural) is preferred, assisted 2nd stage
- Preconception intervention is preferred

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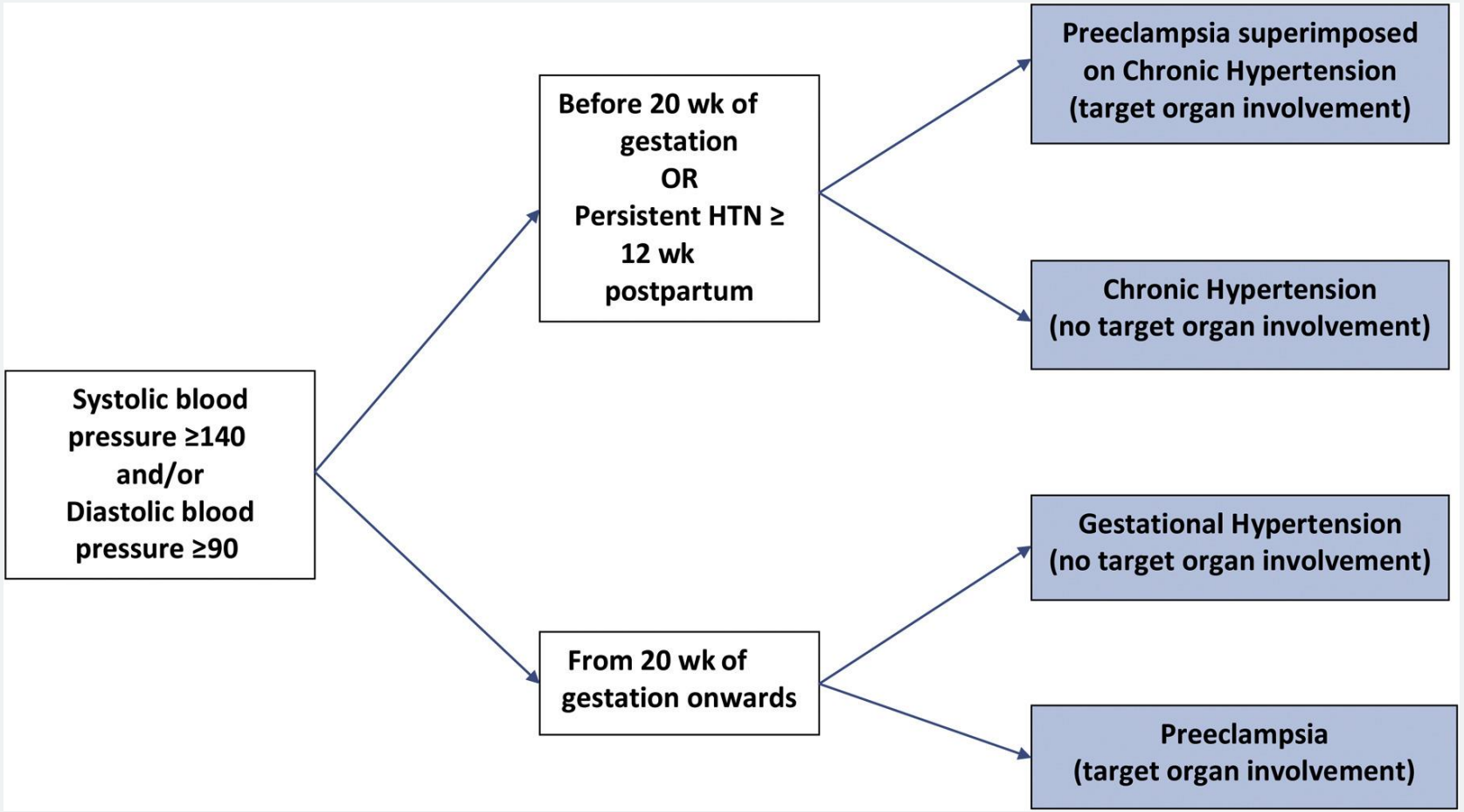
Hypertensive Disorders of Pregnancy



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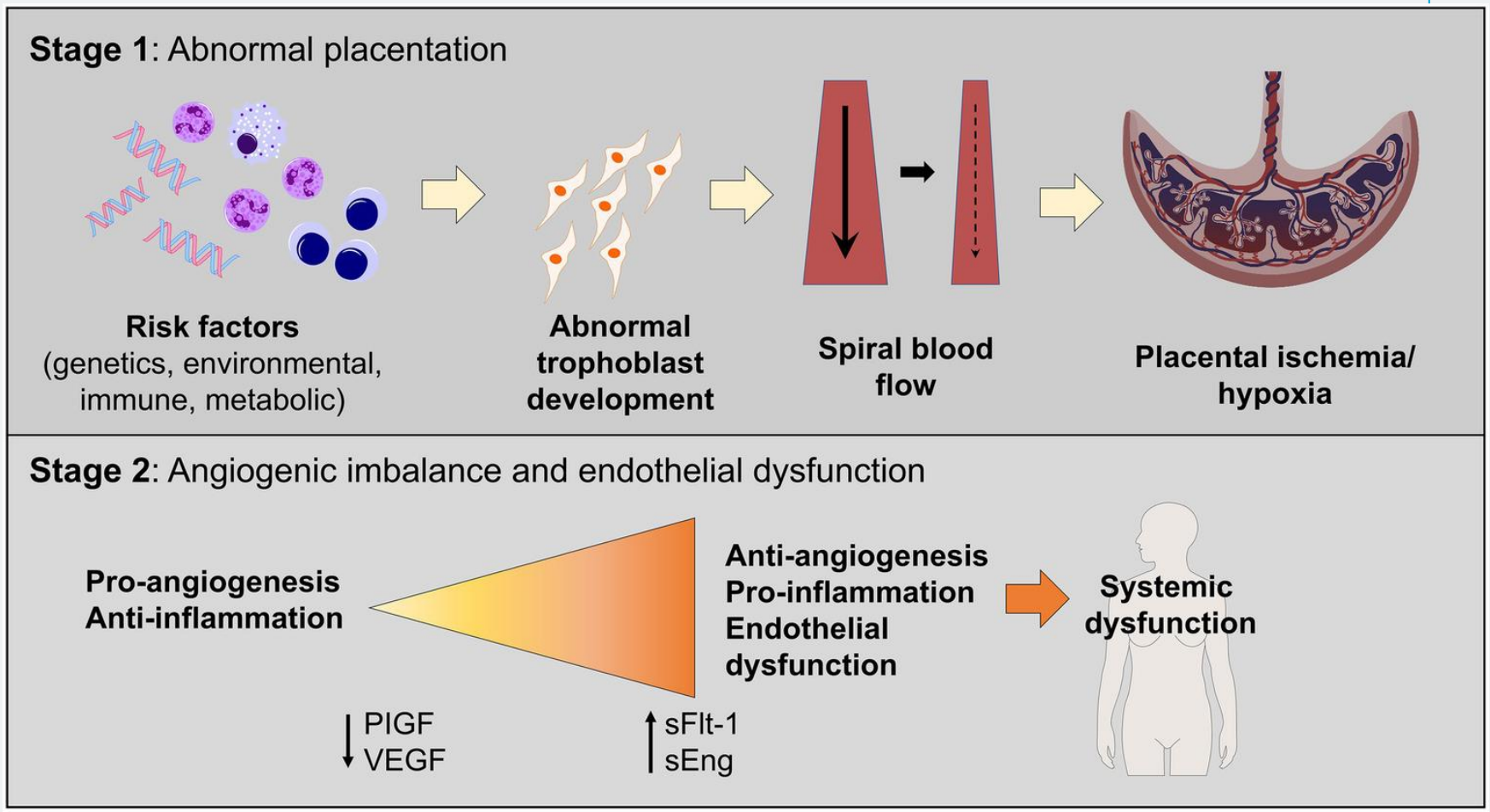
Khedagi, A; Bello, N. *Cardiology Clinics.* Volume 39, Issue 1, 2021; (77-90)

Preeclampsia - Pathogenesis



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Bisson, C et al. *Front. Med.* 2023

Preeclampsia

Preeclampsia Definitions

Preeclampsia

- Hypertension and proteinuria **or**
- In absence of proteinuria, new-onset hypertension with the new onset of any of the following
  - Thrombocytopenia: Platelets <100 x 10^9/L
  - Renal insufficiency: serum creatinine >1.1 mg/dl or doubling of serum creatinine in the absence of other renal disease
  - Impaired liver function: Elevated blood concentrations of liver transaminases to twice normal concentration
  - Pulmonary edema
  - Neuro: Unexplained new-onset headache unresponsive to medication (without an alternative diagnosis) **or** visual symptoms

Preeclampsia with severe features

- Preeclampsia diagnosis, above, with any of the following
  - Severe hypertension
    - On two occasions at least 4 hours apart while on bed rest (unless already on antihypertensive therapy)
  - Thrombocytopenia: Platelets <100 x 10^9/L
  - Impaired liver function (without an alternative diagnosis): Elevated liver transaminases greater than twice upper limit of normal **or** severe persistent right upper quadrant **or** epigastric pain not responsive to medications
  - Progressive renal insufficiency: serum creatinine >1.1 mg/dl or doubling of serum creatinine in the absence of other renal disease
  - Pulmonary edema
  - Neuro: Unexplained new-onset headache unresponsive to medication (without an alternative diagnosis) **or** visual symptoms

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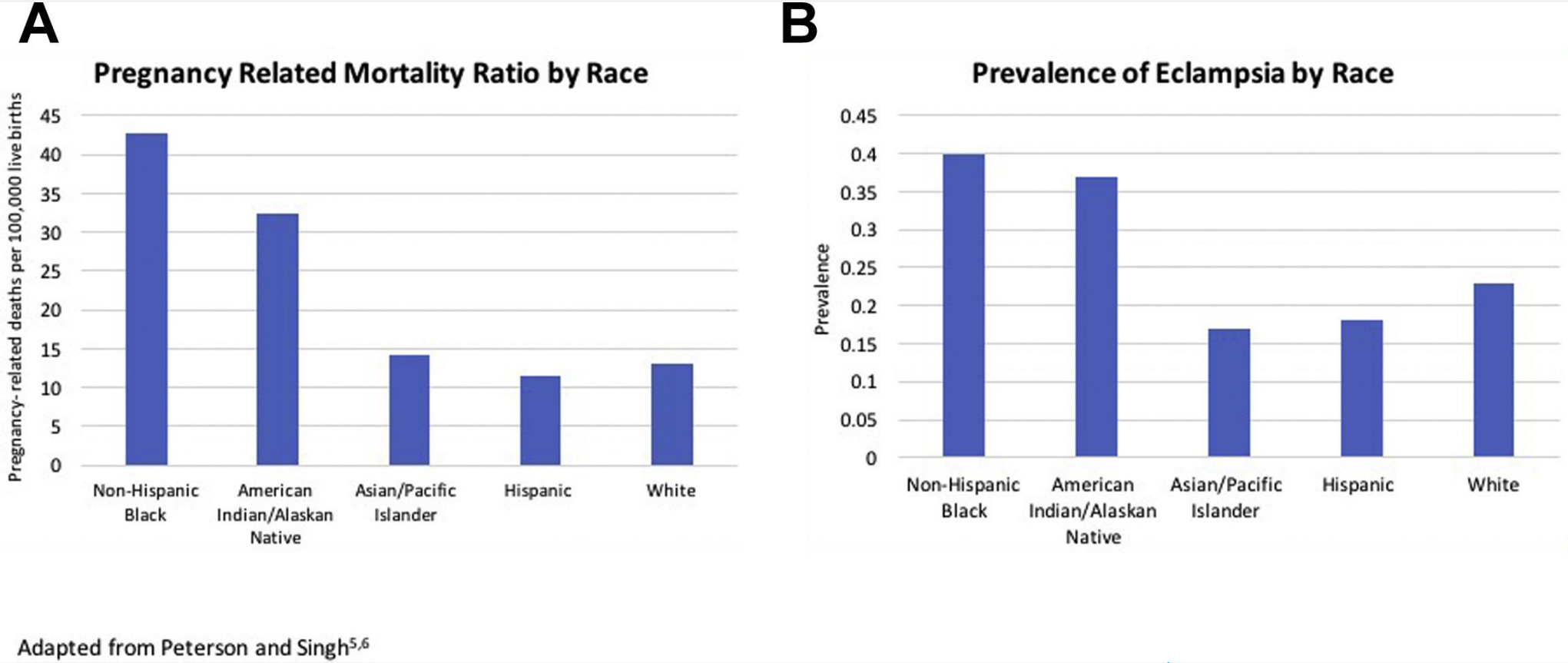
Preeclampsia



Adapted from Peterson and Singh[5,6]

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Khedagi, A; Bello, N. *Cardiology Clinics.* Volume 39, Issue 1, 2021; (77-90)

Preeclampsia

Level of Risk	Risk Factors	Recommendation
High[†]	• History of preeclampsia, especially when accompanied by an adverse outcome • Multifetal gestation • Chronic hypertension • Type 1 or 2 diabetes • Renal disease • Autoimmune disease (ie, systemic lupus erythematosus, the antiphospholipid syndrome)	Recommend low-dose aspirin if the patient has one or more of these high-risk factors
Moderate[‡]	• Nulliparity • Obesity (body mass index greater than 30) • Family history of preeclampsia (mother or sister) • Sociodemographic characteristics (African American race, low socioeconomic status) • Age 35 years or older • Personal history factors (eg, low birth weight or small for gestational age, previous adverse pregnancy outcome, more than 10-year pregnancy interval)	Consider low-dose aspirin if the patient has more than one of these moderate-risk factors[§]
Low	• Previous uncomplicated full-term delivery	Do not recommend low-dose aspirin

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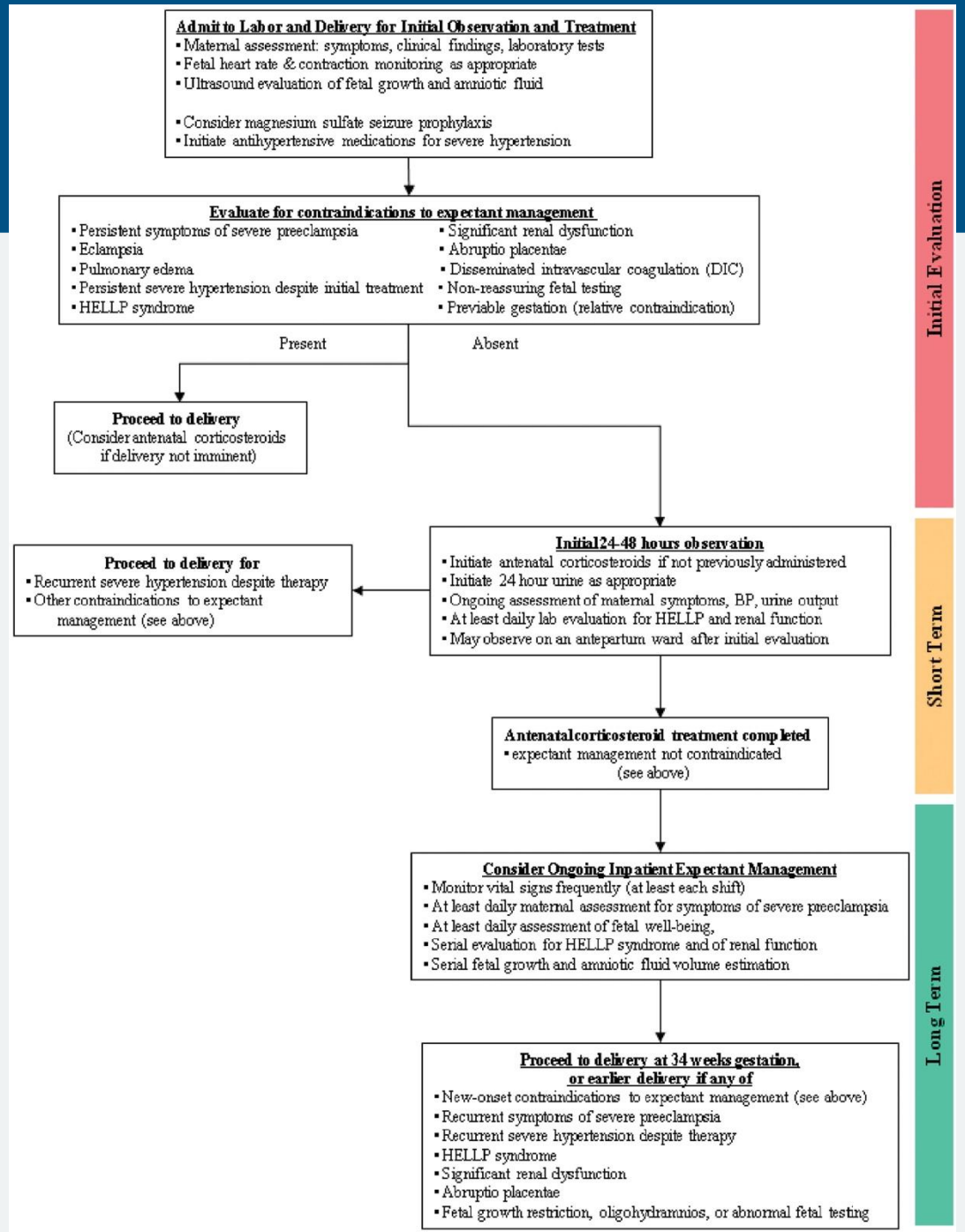
ACOG Clinical Committee Opinion Number 743, July 2018 (Reaffirmed 2023)

Preeclampsia



Sibai, B. *AJOG*, Volume 205, Issue 3 191-198

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Preeclampsia

Table2. Antihypertensive medications for pregnant women with nonsevere hypertension

	Agent	Dose	Side Effects
First line	Labetalol (PO)	100–200mg BID (increase Q 2–3d to max dosage 2400mg/d)	Hypotension, increased liver enzyme Levels, persistent fetal bradycardia, and neonatal hypoglycemia Avoid in asthma because of risk of bronchospasm
	Extended-release nifedipine (PO)	30–60mg Q day (increase Q 7–14d to max dosage 120mg/d)	Severe headache, peripheral edema
	Methyldopa (PO)	250mg BID or TID (increase Q 2d to max dose 3000mg/d)	Sedative, peripheral edema, anxiety, nightmares, dry mouth, hypotension, Contraindicated in depression
Second or Third line	Hydrochlorothiazide	12.5mg Q day (increase Q 7-14d to max dosage 50mg/d)	Volume depletion, fetal growth restriction, oligohydramnios
	Hydralazine	10mg QID (increase Q 2–5d to max dosage 200mg/d)	Tachycardia, headache, flushing, fetal distress, hypotension, and inhibition of labor especially when combined with magnesium sulfate Should never be used in isolation because of reflex tachycardia

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Khedagi, A; Bello, N. *Cardiology Clinics.* Volume 39, Issue 1, 2021; (77-90)

Hypertensive Disorder of Pregnancy - Longterm

CENTRAL ILLUSTRATION: Risk Factors for a Premature Cardiovascular Event

Longitudinal cohort study linked with electronic medical records

Population: 10,368 parous Australian women, 1,493 (14.4%) with hypertensive disorder of pregnancy, 448 (4.3%) with a premature cardiovascular events (before age 50 years)

Risk of Major Premature Cardiovascular Event	
Factor	Adjusted Hazard Ratio (95% Confidence Interval)
Hypertensive disorder of pregnancy	1.74 (1.32-2.31)
Obesity	1.60 (1.19-2.15)
Saturated fat >319 g/day	1.67 (1.11-2.53)
Breastfeeding >16 months	0.66 (0.49-0.89)
Protein >90 g/day	0.65 (0.43-0.96)

The association between smoking, the Australian Recommended Food Score diet and the glycemic index with premature cardiovascular events differs in women with and without hypertensive disorders of pregnancy.

- Young women with hypertensive disorder of pregnancy are at an almost 2-fold risk of premature cardiovascular events.
- The association between some lifestyle risk factors and premature cardiovascular events varies according to hypertensive disorders of pregnancy status.

Marschner SL, et al. JACC Adv. 2026;5(10):103187.

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Take Home Points

- Physiologic changes in pregnancy affect outcomes
- Preconception counseling is important
- Multidisciplinary management improves outcomes
- High mortality with severe mitral and symptomatic severe aortic valve stenosis
- Hypertensive disorders in pregnancy are common among black women and have lifetime cardiovascular consequences

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Thank you for your attention!

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