GEORGIA PERINATAL QUALITY COLLABORATIVE

Cardiac Lecture Series #1: Cardiac Physiology

October 4, 2022

Updates

Additional Learning Event **October 5th**

- Topic: CVD Related Maternal Mortality - Emory Grand Rounds
  Speaker: Afshan Hameed, MD

Next Maternal Webinar **November 1st**

- Topic: Cardiac Warning Signs | Speaker: Natalie Poliektov, MD

Maternal HTN Data Reporting

- Q3 2022 (July-Sept DUE October 31st) – can report for existing or new metrics
- Submission instructions will be sent shortly

Cardiac Initiative Recruitment – through October 31st

- Onboarding call for active cohort
- 1st Data Submission Q4 2022 (Oct-Dec) DUE January 31st

Cardiac Consultation and Referral Network Assessment

AIM

ALLIANCE FOR INNOVATION ON MATERNAL HEALTH

Cardiac Conditions in Obstetrical Care

Enroll your hospital NOW ♥

https://georgiapqc.org/cardiac-conditions

Key Driver Diagram: Maternal Cardiac Conditions

GOAL: To reduce severe morbidity/mortality related to maternal cardiac conditions in Georgia.

SMART AIM: By 02/6/2026, National Wear Red Day, to reduce harm related to existing and pregnancy related cardiac conditions through the 4th trimester by 20%

Key Drivers

Readiness: EVERY UNIT - Implementation of standard processes for optimal care of cardiac conditions in pregnancy and post-partum.

Recognition & Prevention: EVERY PATIENT - Screening and early diagnosis of cardiac conditions in pregnancy and post-partum.

Response: EVERY UNIT - Care management for every pregnant or postpartum woman with cardiac conditions in pregnancy and post-partum.

Reporting/System Learning: EVERY UNIT - Foster a culture of safety and improvement for care of women with cardiac conditions in pregnancy and post-partum.

Respectful, Equitable, and Supportive Care — EVERY UNIT/PROVIDER/TEAM MEMBER - Inclusion of the patient as part of the multidisciplinary care team.

Interventions

- ❑ Train all obstetric care providers to perform a basic Cardiac Conditions Screen.
- ❑ Establish a protocol for rapid identification of potential pregnancy-related cardiac conditions in all practice settings to which pregnant and postpartum people may present.
- ❑ Develop a patient education plan based on the pregnant and postpartum person's risk of cardiac conditions.
- ❑ **Establish a multidisciplinary "Pregnancy Heart Team" or consultants appropriate to their facility's designated Maternal Level of Care to design coordinated clinical pathways for people experiencing cardiac conditions in pregnancy and the postpartum period.** S1
- ❑ Establish coordination of appropriate consultation, co-management and/or transfer to appropriate level of maternal or newborn care.
- ❑ Develop trauma-informed protocols and training to address health care team member biases to enhance quality of care
- ❑ Develop and maintain a set of referral resources and communication pathways between obstetric providers, community-based organizations, and state and public health agencies to enhance quality of care. *

- ❑ Obtain a focused pregnancy and cardiac history in all care settings, including emergency department, urgent care, and primary care.
- ❑ **In all care environments assess and document if a patient presenting is pregnant or has been pregnant within the past year.** S2
- ❑ Assess if escalating warning signs for an imminent cardiac event are present.
- ❑ Utilize standardized cardiac risk assessment tools to identify and stratify risk.
- ❑ Conduct a risk-appropriate work-up for cardiac conditions to establish diagnosis and implement the initial management plan.

- ❑ Facility-wide standard protocols with checklists and escalation policies for management of cardiac symptoms.
- ❑ Facility-wide standard protocols with checklists and escalation policies for management of people with known or suspected cardiac conditions.
- ❑ Coordinate transitions of care including the discharge from the birthing facility to home and transition from postpartum care to ongoing primary and specialty care.
- ❑ Offer reproductive life planning discussions and resources, including access to a full range of contraceptive options in accordance with safe therapeutic regimens. *
- ❑ **Provide patient education focused on general life-threatening postpartum complications and early warning signs, including instructions of who to notify if they have concerns, and time and date of a scheduled postpartum visit.** S3

- ❑ For pregnant and postpartum people at high risk for a cardiac event, establish a culture of multidisciplinary planning, admission huddles and post-event debriefs.
- ❑ **Perform multidisciplinary reviews of serious complications (e.g. ICU admissions for other than observation) to identify systems issues.** S4
- ❑ Monitor outcomes and process data related to cardiac conditions, with disaggregation by race and ethnicity due to known disparities in rates of cardiac conditions experienced by Black and Indigenous pregnant and postpartum people. Process Measures – 1-5

- ❑ Screen for structural and social drivers of health that might impact clinical recommendations or treatment plans and provide linkage to resources that align with the pregnant or postpartum person's health literacy, cultural needs, and language proficiency.
- ❑ Engage in open, transparent, and empathetic communication with pregnant and postpartum people and their identified support network to understand diagnoses, options, and treatment plans.
- ❑ **Include each pregnant or postpartum person and their identified support network as respected members of and contributors to the multidisciplinary care team.** *S5

GaPQC
GEORGIA PERINATAL QUALITY COLLABORATIVE

GaPQC CCOC Workgroup

Obstetrics & Gynecology | Maternal Fetal Medicine | Midwifery | Cardiology
Anesthesiology | Emergency Medicine | Family Medicine | Maternal Education

Victoria Gordon RN, MSN, CNM
Melissa Kottke MD, MPH, MBA
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Iris Krishna, MD, MPH, FACOG

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Marcus Williams, MD
Tondra Newman, MD
Shelly Norris, MD
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Lisa Ehle, MPH
Tonia Ruddock, MPH
Victoria Sanon, MPH

4
Subgroups

CCOC Subgroups and Work in Progress

Intentional Cardiac Screening

- Cardiac Screening Tools – Clinician and Patient

Clinician and Patient Education

- Education Plans

Acute Management of the Cardiac Patient

- Quick Reference Guide

Consultation and Referrals

- Statewide Referral List

Education Planning in Progress

Cardiac Education Subgroup

DATE	TITLE
September 6, 2022	Building Cardio-Ob Team
October 4, 2022	Cardiac Physiology
October 5, 2022	MFM Grand Rounds
November 8, 2022	Cardiac Warning Signs
December 6, 2022	Cardiomyopathy
January 3, 2023	Acute MI/Arrhythmias
February 7, 2023	Aortapathies
March 7, 2023	Valvular Heart Disease
April 4, 2023	Congenital Cardiac Lesions
May 2, 2023	Pulmonary Hypertension
June 6, 2023	OB Anesthesia and L&D Considerations

Tentative Schedule

Maternal Cardiac Disease in Pregnancy: Clinical Pearls

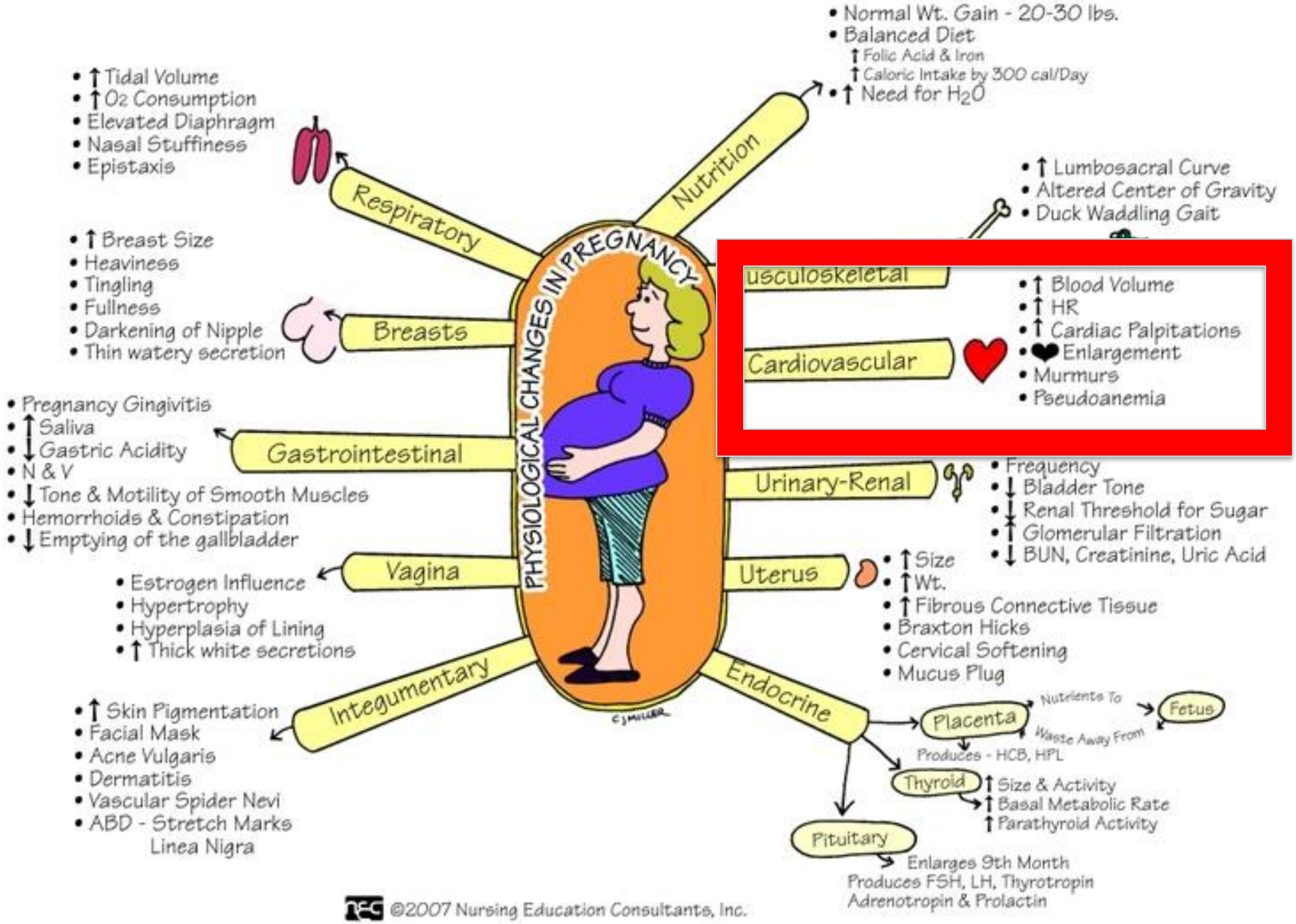
Carolynn Dude, MD, PhD
Division of Maternal Fetal Medicine
Emory University Department of Gynecology & Obstetrics

Objectives

- Review of cardiac physiology
- Brief review of risk stratification
  - WHO
- General Counseling
  - ‘Event risk’
  - Pregnancy management
- Clinical Case Review

Objectives

- Review of cardiac physiology


PHYSIOLOGICAL CHANGES IN PREGNANCY
Respiratory
↑ Tidal Volume
↑ O2 Consumption
Elevated Diaphragm
Nasal Stuffiness
Epistaxis
Nutrition
Normal Wt. Gain - 20-30 lbs.
Balanced Diet
↑ Folic Acid & Iron
↑ Caloric Intake by 300 cal/Day
↑ Need for H2O
Breasts
↑ Breast Size
Heaviness
Tingling
Fullness
Darkening of Nipple
Thin watery secretion
usculoskeletal
↑ Lumbosacral Curve
Altered Center of Gravity
Duck Waddling Gait
Cardiovascular
↑ Blood Volume
↑ HR
↑ Cardiac Palpitations
❤ Enlargement
Murmurs
Pseudoanemia
Gastrointestinal
Pregnancy Gingivitis
↑ Saliva
↓ Gastric Acidity
N & V
↓ Tone & Motility of Smooth Muscles
Hemorrhoids & Constipation
↓ Emptying of the gallbladder
Urinary-Renal
Frequency
↓ Bladder Tone
↓ Renal Threshold for Sugar
↑ Glomerular Filtration
↓ BUN, Creatinine, Uric Acid
Vagina
Estrogen Influence
Hypertrophy
Hyperplasia of Lining
↑ Thick white secretions
Uterus
↑ Size
↑ Wt.
↑ Fibrous Connective Tissue
Braxton Hicks
Cervical Softening
Mucus Plug
Integumentary
↑ Skin Pigmentation
Facial Mask
Acne Vulgaris
Dermatitis
Vascular Spider Nevi
ABD - Stretch Marks
Linea Nigra
Endocrine
Placenta
Nutrients To
Fetus
Waste Away From
Produces - HCG, HPL
Thyroid
↑ Size & Activity
↑ Basal Metabolic Rate
↑ Parathyroid Activity
Pituitary
Enlarges 9th Month
Produces FSH, LH, Thyrotropin
Adrenotropin & Prolactin
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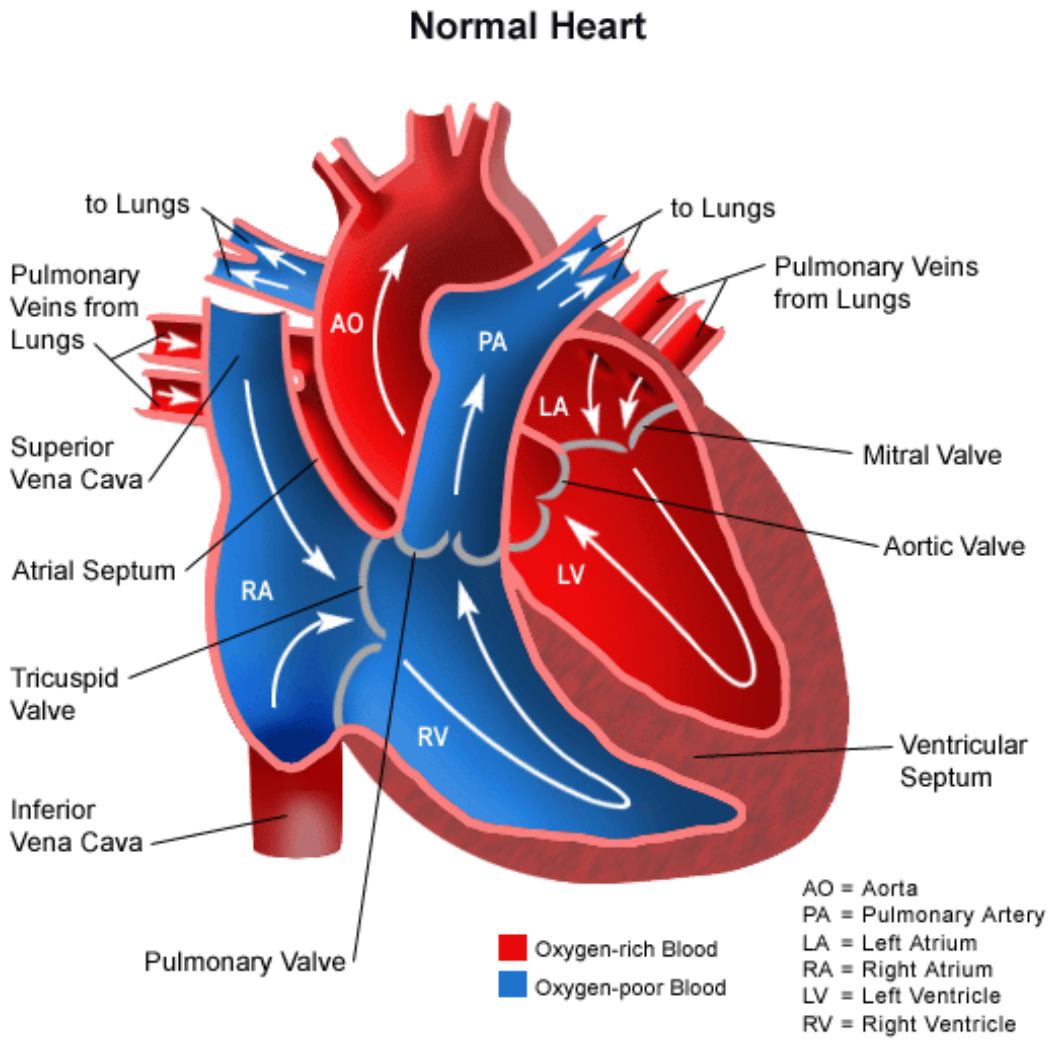
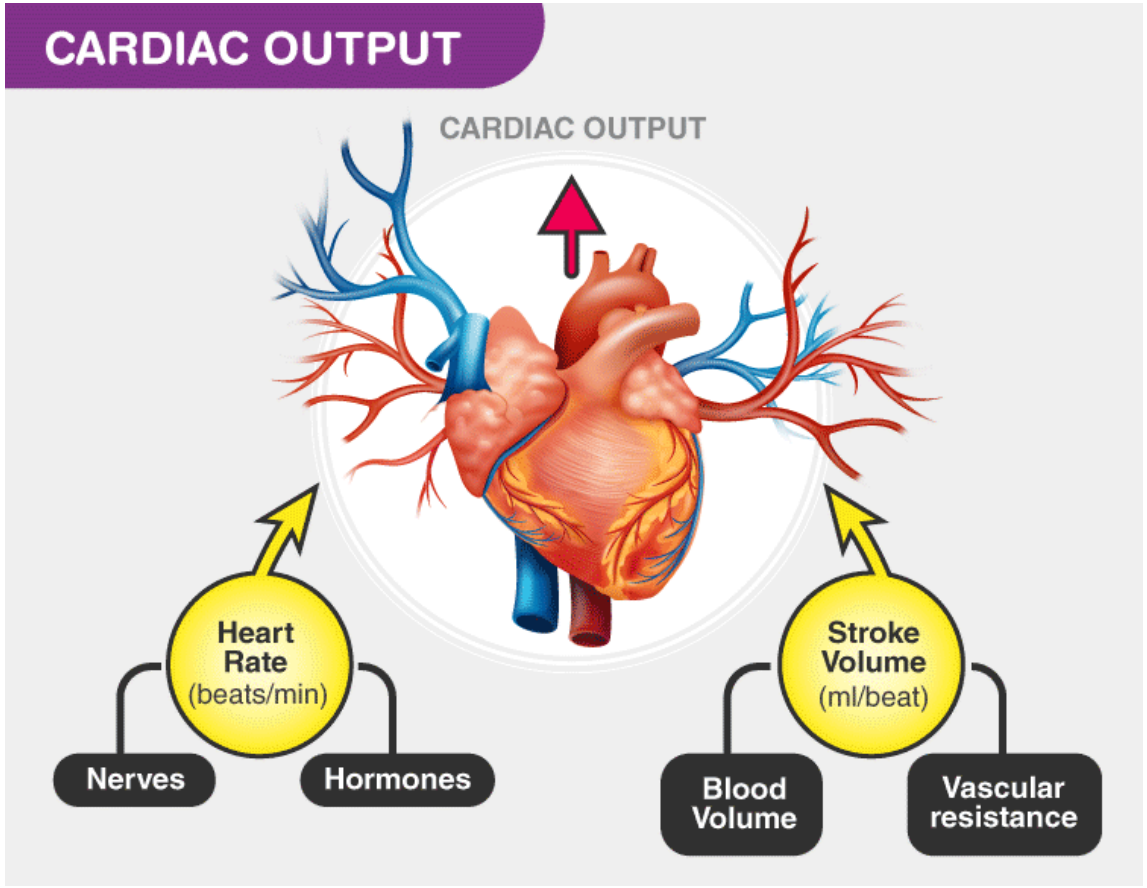
Structural Changes

- LV end diastolic volume increases by 10%
- LV mass increases by 50%, RV mass by 40%
- Up to 20% of patients will have diastolic dysfunction



Physiologic Changes

CARDIAC OUTPUT (CO) =
Stroke Volume (SV) x Heart rate (HR)



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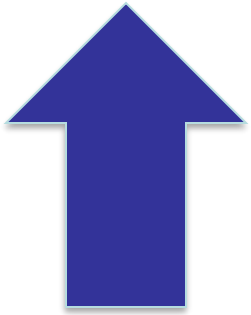
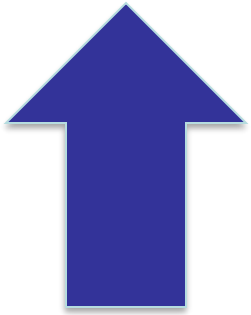
Physiologic Changes



PLASMA VOLUME: Preload

- Stroke volume increases due to volume expansion that begins early in pregnancy
- Plasma reaches *peak volume by approximately 32 weeks*

Physiologic Changes



PLASMA VOLUME: Preload

- Red blood cell (RBC) mass increases 20-30%
- Increased erythropoiesis results in increased iron demand
- Plasma increases *MORE* than RBC mass
  →physiologic hemodilution (‘pseudo’ anemia)

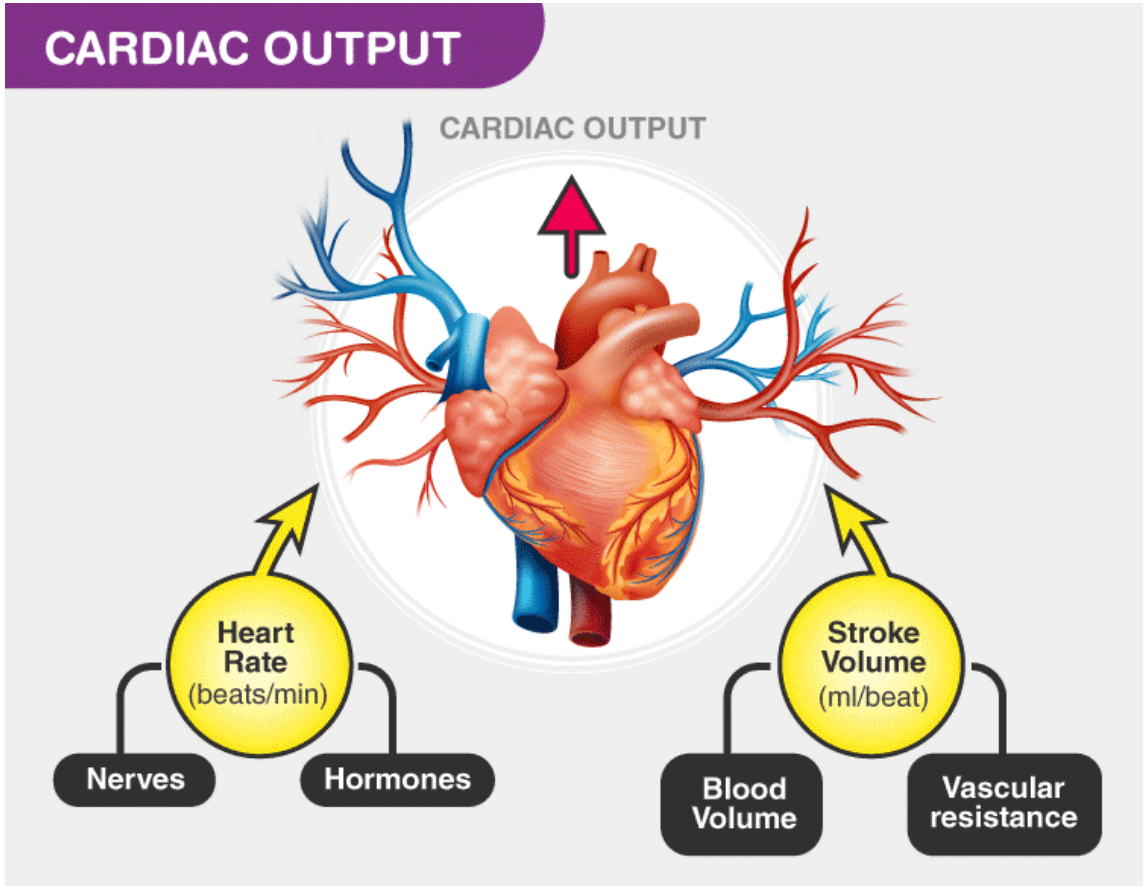
Physiologic Changes

VASCULAR RESISTANCE: Afterload

- During pregnancy, a fall in peripheral vascular resistance (PVR) occurs
- The increase in CO does not completely compensate for the decrease in PVR
- The result is a drop in arterial blood pressure (MAP)

Physiologic Changes

CARDIAC OUTPUT (CO) =
Stroke Volume (SV) x Heart rate (HR)



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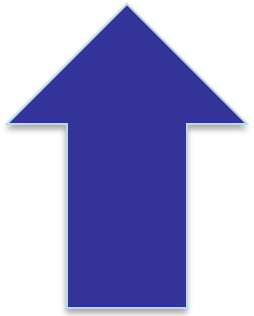
Physiologic Changes



HEART RATE:

- Pulse increases early in the first trimester, and slowly rises throughout pregnancy
- By the middle of the third trimester, resting pulse may be 15-20 beats/minute above baseline
- A **mild** resting tachycardia is normal

Physiologic Changes

	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

ACOG Practice Bulletin No 212: Pregnancy and Heart Disease

Physiologic Changes

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ACOG Practice Bulletin No 212: Pregnancy and Heart Disease

Physiologic Changes: Labor

First Stage of Labor: Cardiac Output increases to 51% term pregnancy values

- **AUTOTRANSFUSION**: Increased venous return from 200-300cc with each contraction
- **PAIN**: May be decreased with epidural pain relief
- **ANXIETY**

Clinical Correlation

REGIONAL ANESTHESIA: Modulates Cardiac Output

- Epidurals cause sympathetic blockade
  - Drops afterload by decreasing SVR
    - Partially mediated by decrease pain (catecholamine surges)
  - But also drops preload
    - Must titrate slowly
    - IV fluids administration

- Spinals cause profound sympathectomy
  - Profound hypotension
  - Should be avoided in cardiac patients, especially preload depedent lesions!

Clinical Correlation

Positioning:

- Supine position lowers Cardiac Output by ~25-30% due to compression of the IVC by the gravid uterus
- This can lead to a substantial reduction in venous return to the heart, decreasing preload
- **Left lateral decubitus** position maximizes Cardiac Output

Physiologic Changes: Labor

Second stage of labor: Cardiac Output decreases

- **VALSALVA** = Increase in intrathoracic pressure
  - Results in decreased venous return → decreased preload
  - Preload dependent lesions require assisted 2nd stage

Physiologic Changes: Labor

Immediately Postpartum: Cardiac Output increases by 60-80%

- Due to release of venal caval obstruction
- Auto transfusion of 500 cc back to the heart

Physiologic Changes

	First Trimester	Second Trimester	Third Trimester	Stage 1 Labor	Stage 2 Labor	Early Postpartum	3–6 months Postpartum
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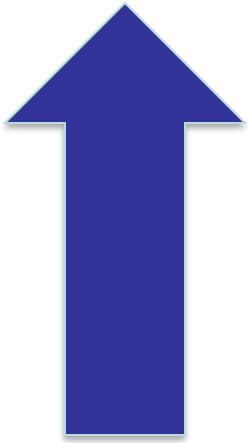
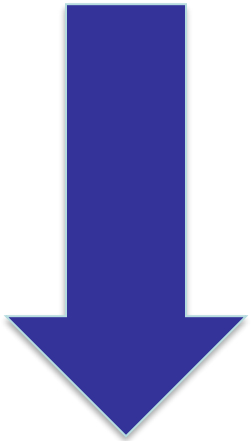
Physiologic Changes

SUMMARY:



Preload
Stroke Volume
Heart Rate
Cardiac Output



Afterload
Systemic Vascular Resistance (SVR)

Objectives

- Review of cardiac physiology
- **Brief review of risk stratification**
  - **WHO**
- General Counseling
  - ‘Event risk’
  - Pregnancy management
- Clinical Case Review

New York Heart Association Functional Class

CLASS I
No symptoms with ordinary physical activity

CLASS II
Some symptoms with ordinary activity and slight limitation of physical activity

CLASS III
Symptoms with less than ordinary activity and increased limitation of physical activity

CLASS IV
Symptoms with any activity, possibly even while at rest

WHO Classification

GUIDELINES

ESC Guidelines on the management of cardiovascular diseases during pregnancy: The Task Force on the Management of Cardiovascular Diseases during Pregnancy of the European Society of Cardiology (ESC) FREE

Endorsed by the European Society of Gynecology (ESG), the Association for European Paediatric Cardiology (AEPC), and the German Society for Gender Medicine (DGesGM), Authors/Task Force Members, Vera Regitz-Zagrosek ✉, Carina Blomstrom Lundqvist, Claudio Borghi, Renata Cifkova, Rafael Ferreira, Jean-Michel Foidart, J. Simon R. Gibbs, Christa Gohlke-Baerwolf ... Show more

Author Notes

European Heart Journal, Volume 32, Issue 24, December 2011, Pag
https://doi.org/10.1093/eurheartj/ehr218
Published: 26 August 2011

Risk class	Risk of pregnancy by medical condition
I	No detectable increased risk of maternal mortality and no/mild increase in morbidity.
II	Small increased risk of maternal mortality or moderate increase in morbidity.
III	Significantly increased risk of maternal mortality or severe morbidity. Expert counselling required. If pregnancy is decided upon, intensive specialist cardiac and obstetric monitoring needed throughout pregnancy, childbirth, and the puerperium.
IV	Extremely high risk of maternal mortality or severe morbidity; pregnancy contraindicated. If pregnancy occurs termination should be discussed. If pregnancy continues, care as for class III.

WHO Classification

Conditions in which pregnancy risk is WHO I
• 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
Conditions in which pregnancy risk is WHO II or III
WHO II *(if otherwise well and uncomplicated)*
• Unoperated atrial or ventricular septal defect
• Repaired tetralogy of Fallot
• Most arrhythmias
WHO II–III *(depending on individual)*
• Mild left ventricular impairment
• Hypertrophic cardiomyopathy
• Native or tissue valvular heart disease not considered WHO I or IV
• Marfan syndrome without aortic dilatation • Aorta <45 mm in aortic disease associated with bicuspid aortic valve
• Repaired coarctation

WHO III
• Mechanical valve
• Systemic right ventricle
• Fontan circulation
• Cyanotic heart disease (unrepaired)
• Other complex congenital heart disease
• Aortic dilatation 40–45 mm in Marfan syndrome • Aortic dilatation 45–50 mm in aortic disease associated with bicuspid aortic valve
Conditions in which pregnancy risk is WHO IV (pregnancy contraindicated)
• Pulmonary arterial hypertension of any cause
• Severe systemic ventricular dysfunction (LVEF <30%, NYHA III–IV)
• Previous peripartum cardiomyopathy with any residual impairment of left ventricular function
• Severe mitral stenosis, severe symptomatic aortic stenosis
• Marfan syndrome with aorta dilated >45 mm • Aortic dilatation >50 mm in aortic disease associated with bicuspid aortic valve
• Native severe coarctation

Objectives

- Review of cardiac physiology
- Brief review of risk stratification
  - WHO
- General Counseling
  - ‘Event risk’
  - Pregnancy management
- Clinical Case Review

CARPREG – Risk Index

Prospective Multicenter Study of Pregnancy Outcomes in Women With Heart Disease

Samuel C. Siu, Mathew Sermer, Jack M. Colman, A. Nanette Alvarez, Lise-Andree Mercier, Brian C. Morton, Catherine M. Kells, M. Lynn Bergin, Marla C. Kiess, Francois Marcotte, Dylan A. Taylor … Show all Authors

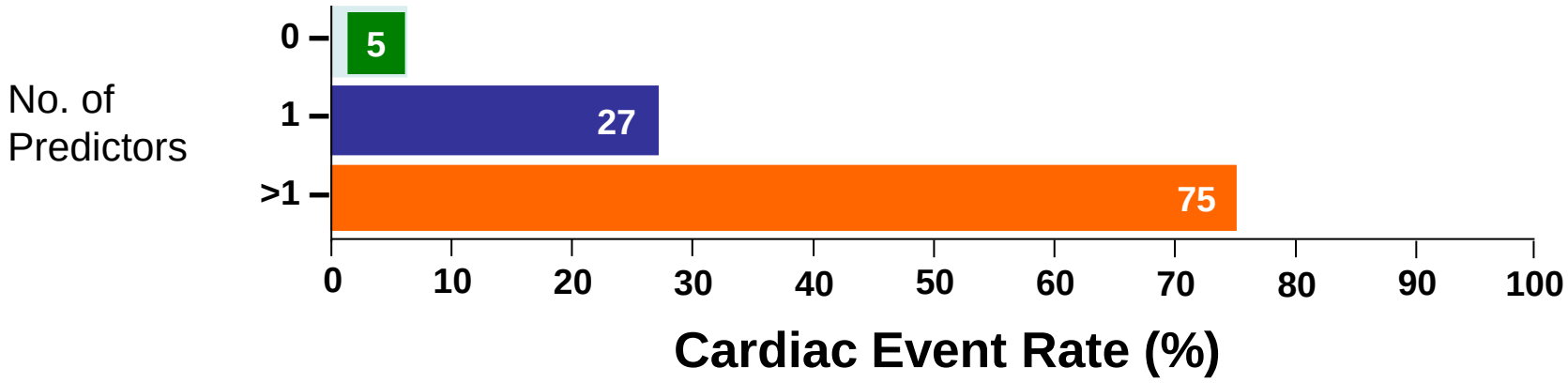
Originally published 31 Jul 2001 | https://doi.org/10.1161/hc3001.093437 | Circulation. 2001;104:515–521

Circulation

CARPREG – Risk Index

Primary cardiac events

1. Pulmonary Edema
2. Sustained tachyarrhythmia/bradyarrhythmia
3. Stroke
4. Cardiac arrest
5. Cardiac death



CARPREG – Risk Index

Predictors for primary cardiac events

1. Prior cardiac event (CHF, stroke, arrhythmia)

2. NYHA Class III or IV or hypoxemia (O2 sat < 90%)

3. Left heart obstructive lesion
   - **MVA < 2cm^2**
   - **AVA < 1.5cm^2**
   - **Peak LVOT gradient >30 mmHg**
4. LV Ejection Fraction < 40%

CARPREG – Risk Index

Primary cardiac events

1. Pulmonary Edema
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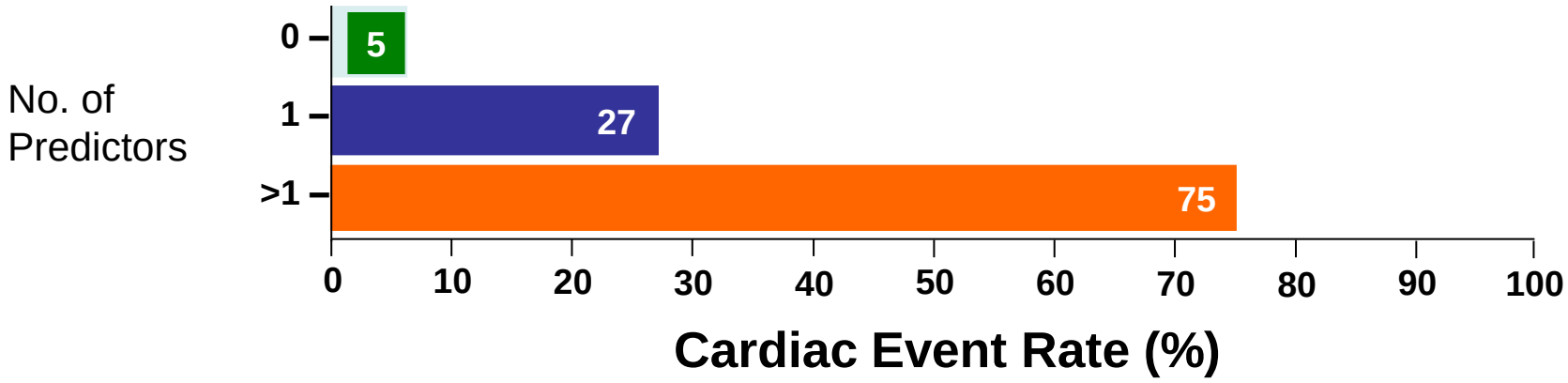


Antepartum

- Potential concerns antepartum are based on **type of lesion and functional status**

First trimester:

- **Establish baseline functional status, assess for cyanosis**
- **Review medications, Hep C screening**
- **Baseline echocardiogram / initial visit with cardiology**
- **Genetic screening**

Second trimester:

- **Anatomy scan, serial growth scans**
- **Fetal echocardiogram if appropriate**

Third Trimester:

- **Repeat echocardiogram, repeat visit with cardiology**
- **Anesthesia consult**
- **Antenatal testing?**
- **Delivery planning**

Intrapartum/Postpartum

- **All (Majority) patients need:**
  - **Telemetry** intrapartum, some period postpartum (6-24 hours)
  - **Strict I/Os, +/- endocarditis prophylaxis**
  - **Attention to VS, avoiding extreme tachycardia**
  - Often **early PCEA**
  - **+/- Assisted second stage**

  ****Careful with the Terbutaline** (causes tachycardia)**

- **Postpartum is high risk time, especially in lesions leading to left outflow obstruction**

Objectives

- Review of cardiac physiology
- Brief review of risk stratification
  - WHO
- General Counseling
  - ‘Event risk’
  - Pregnancy management
- **Clinical Case Review**

Case 1: Patient T.P.

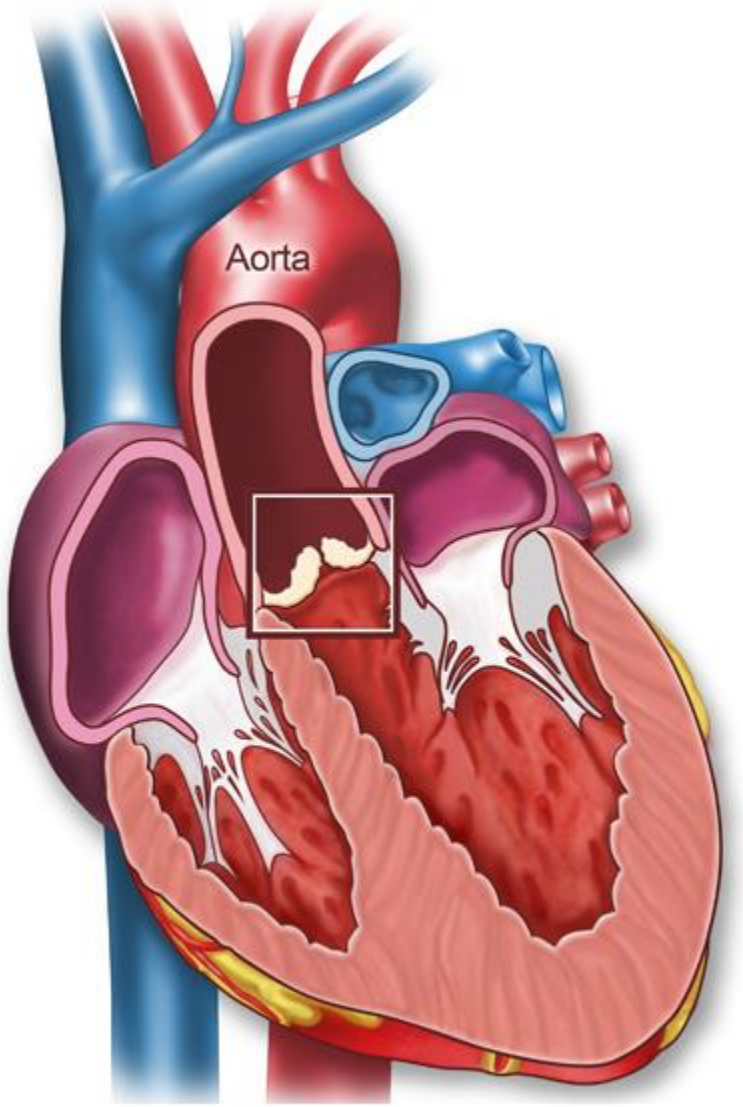
- 43yo G3P1011 at 37w0d with a history of:
  - **Aortic stenosis** with an **echo** showing:
    - **EF 65%**
    - **Moderate concentric LVH with severe diastolic dysfunction**
    - **Heavily calcified aortic valve with severely decreased aortic valve excursion**
    - **Critical AS with peak gradient 141 mmHg and AV valve 0.61cm^2**
    - **Dilated ascending aorta 4.5 cm**

Stenotic Lesions

- Physiologic increase in preload
  - Pregnancy may make stenotic lesions **more symptomatic**
- Left sided (too much going in through a small hole) – fluid back ups into the **LUNGS**
- Right sided – fluid backs up into **liver and extremities**

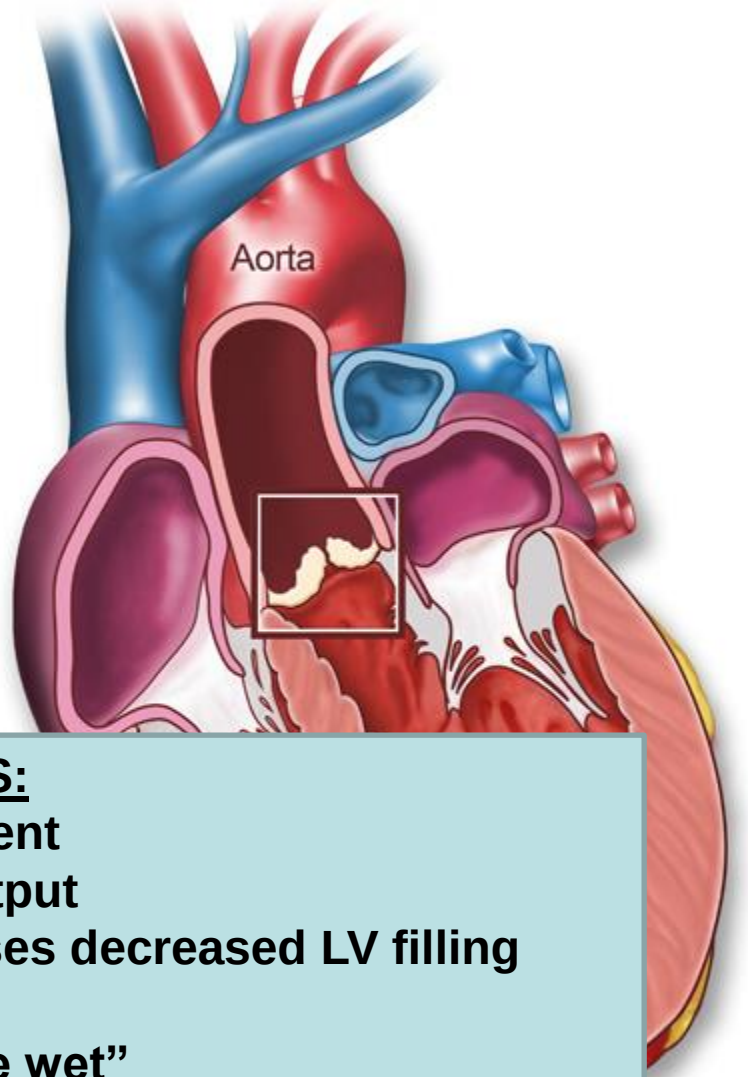
Aortic Stenosis

- Mild and moderate AS is usually well tolerated
- Physiologic increase preload
  - Intolerance of increasing fluid/pulmonary edema
  - Atrial/ventricular arrhythmias
- As stenosis becomes more severe, heart may have trouble maintaining CO
  - Heart failure
  - Arrhythmias



Aortic Stenosis

- TACHYCARDIA is problematic and causes decreased LV filling



<u>Summary of AS:</u>
Preload dependent
Fixed cardiac output
Tachycardia is problematic and causes decreased LV filling
Early epidural
Fluid: better “a little wet”
Maternal Monitoring: Telemetry/ possible Arterial Line
Fetal Monitoring: per obstetric protocol

Maternal Cardiac Disease in Pregnancy: Clinical Pearls

Thank you!

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GaPQC

GEORGIA PERINATAL QUALITY COLLABORATIVE

Questions?

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