Cardio-
OBSTETRICS

Sunnybrook Grand Rounds
February 7, 2025

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INTRODUCTION

Why Cardio Obstetrics?

Why Cardio Obstetrics?

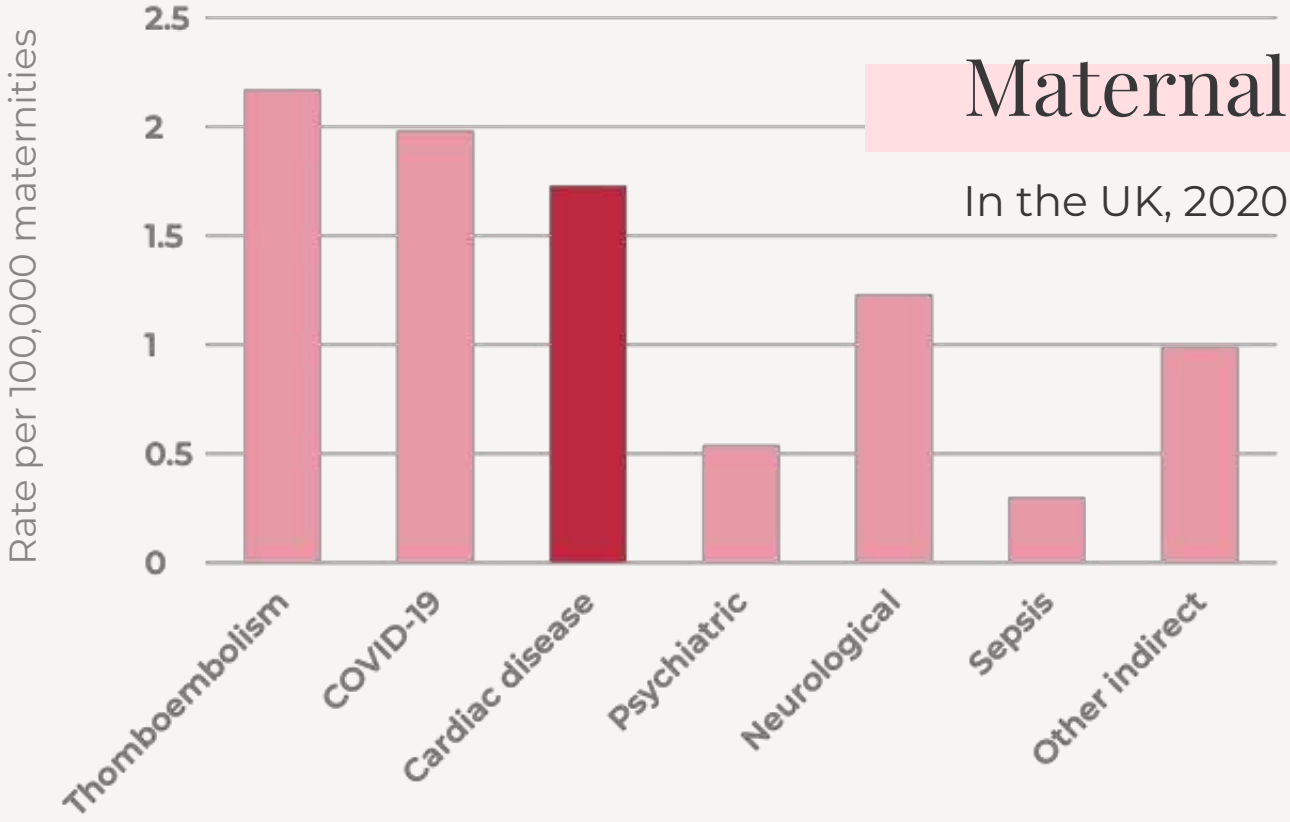
- Cardiac disease affects **1-4% of all pregnancies**, and this will increase
- OB population is becoming older, and has more comorbidities. More **acquired heart disease**.
- Growing population of adults with **congenital heart disease** seeking pregnancy

Why Cardio Obstetrics?

- Cardiac disease is the **leading cause of indirect maternal mortality** in countries like the UK and the US

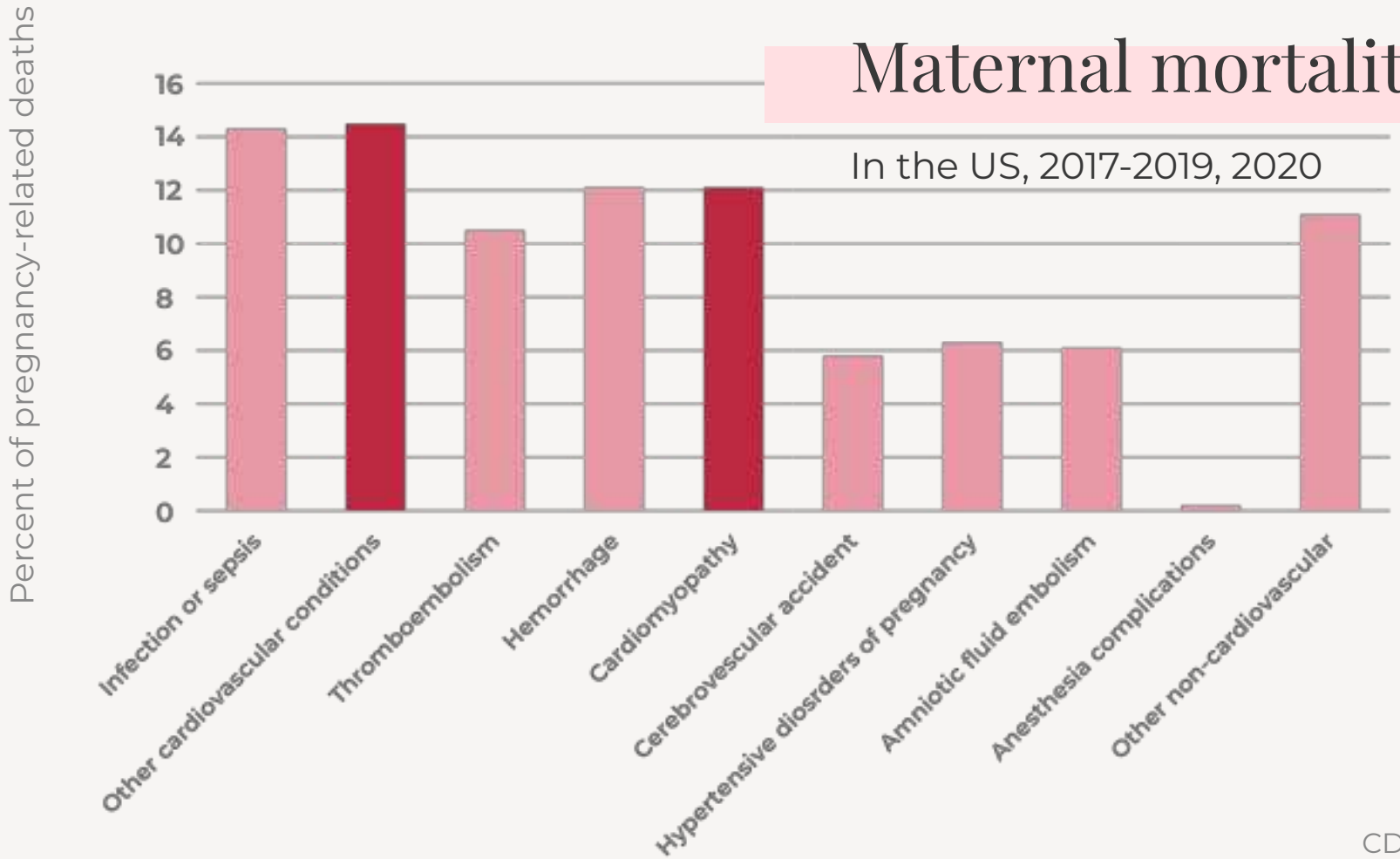
Maternal mortality

In the UK, 2020-2022



Maternal mortality

In the US, 2017-2019, 2020



CDC 2022

Common conditions

Congenital heart disease

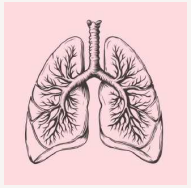
Valvular disease

Cardiomyopathy

Heart failure

Arrhythmias

Coronary artery disease



Pulmonary hypertension

Aortopathy

AGENDA

1. Physiology
2. Risk assessment
3. Intrapartum management
4. Postpartum management
5. Perimortem c-section
6. Discussion

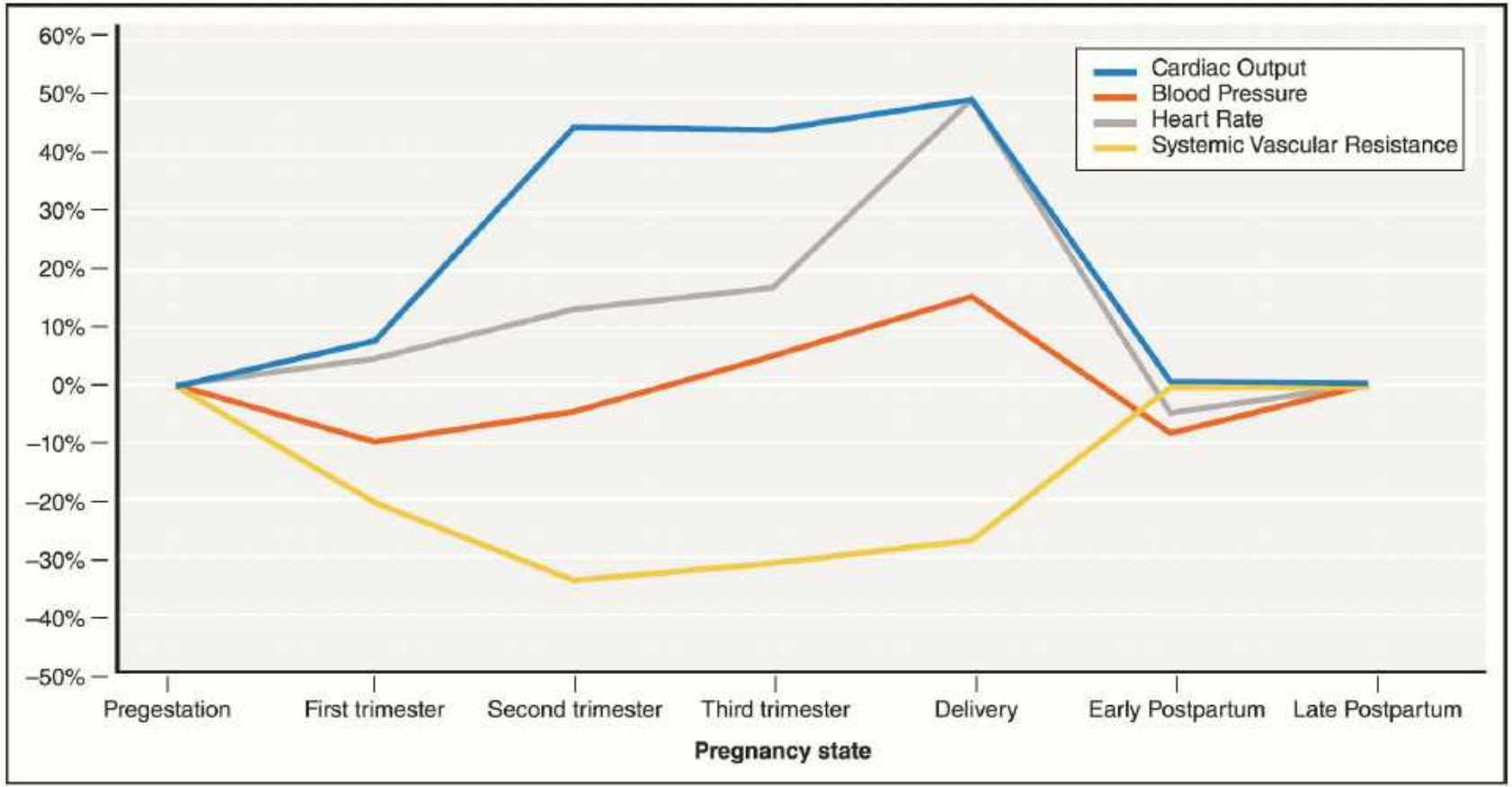
1

PHYSIOLOGY

How does the body adapt to pregnancy?

How does the body adapt to pregnancy?

- Significant physiologic and hemodynamic changes occur to meet the demands of pregnancy
- Can unmask undiagnosed heart conditions
- Can exacerbate existing heart conditions



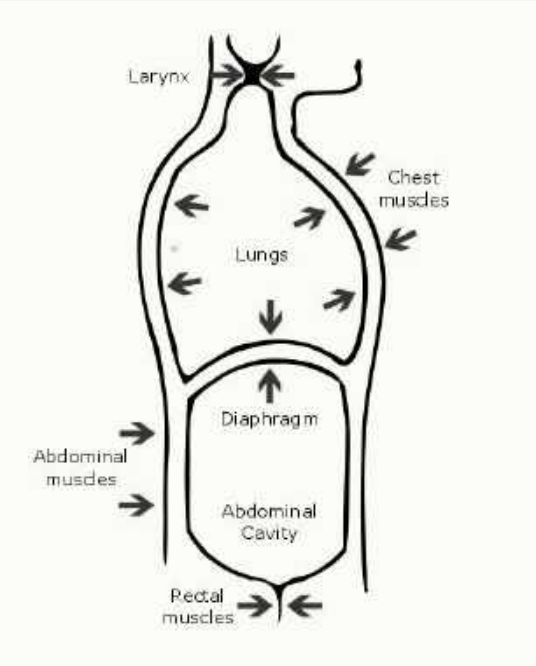
Mehta et al 2020

Labour

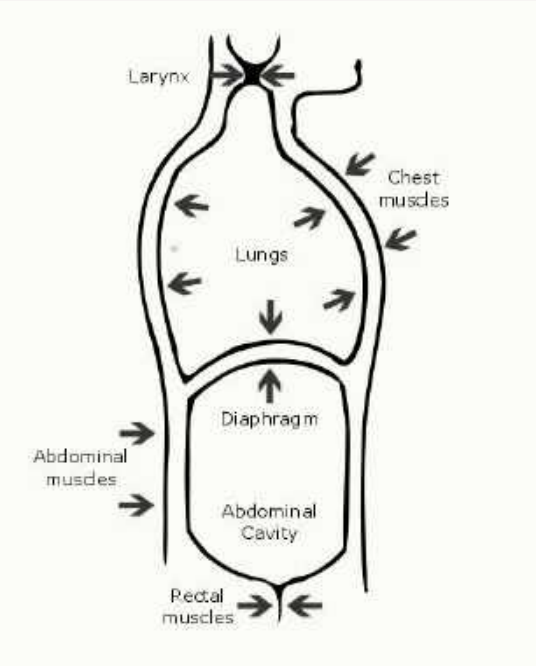
Elkayam et al 2016

Labour

- Oxygen consumption increases x3
- Blood pressure increases
- **Cardiac output increases**
  - First stage - 30%
  - Active second stage – 50%
- **Contraction causes an autotransfusion** of 300-500ml from uterus to systemic circulation


Larynx
Chest muscles
Lungs
Diaphragm
Abdominal muscles
Abdominal Cavity
Rectal muscles

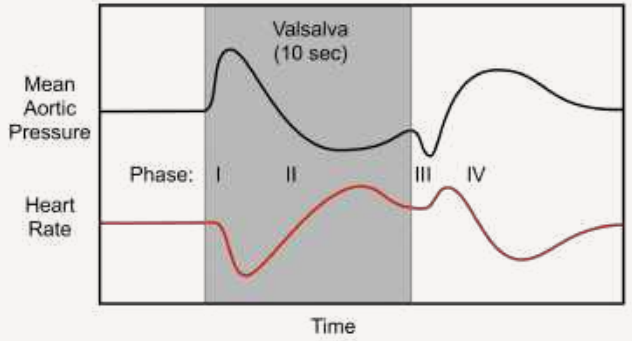
Pushing



Canobbio et al 2017

Pushing

- Increases intrathoracic pressure
- Dec venous return
- Dec preload
- Dec cardiac output

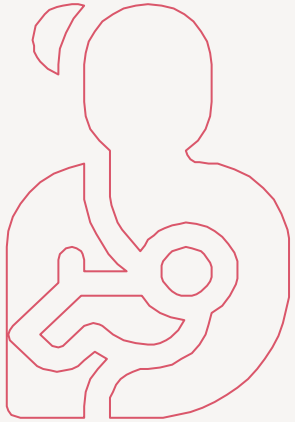


Canobbio et al 2017

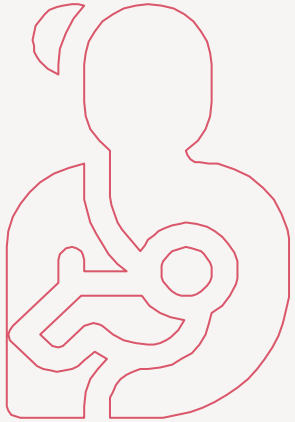
Pushing

As reflex:

- Blood pressure increases
- Heart rate drops



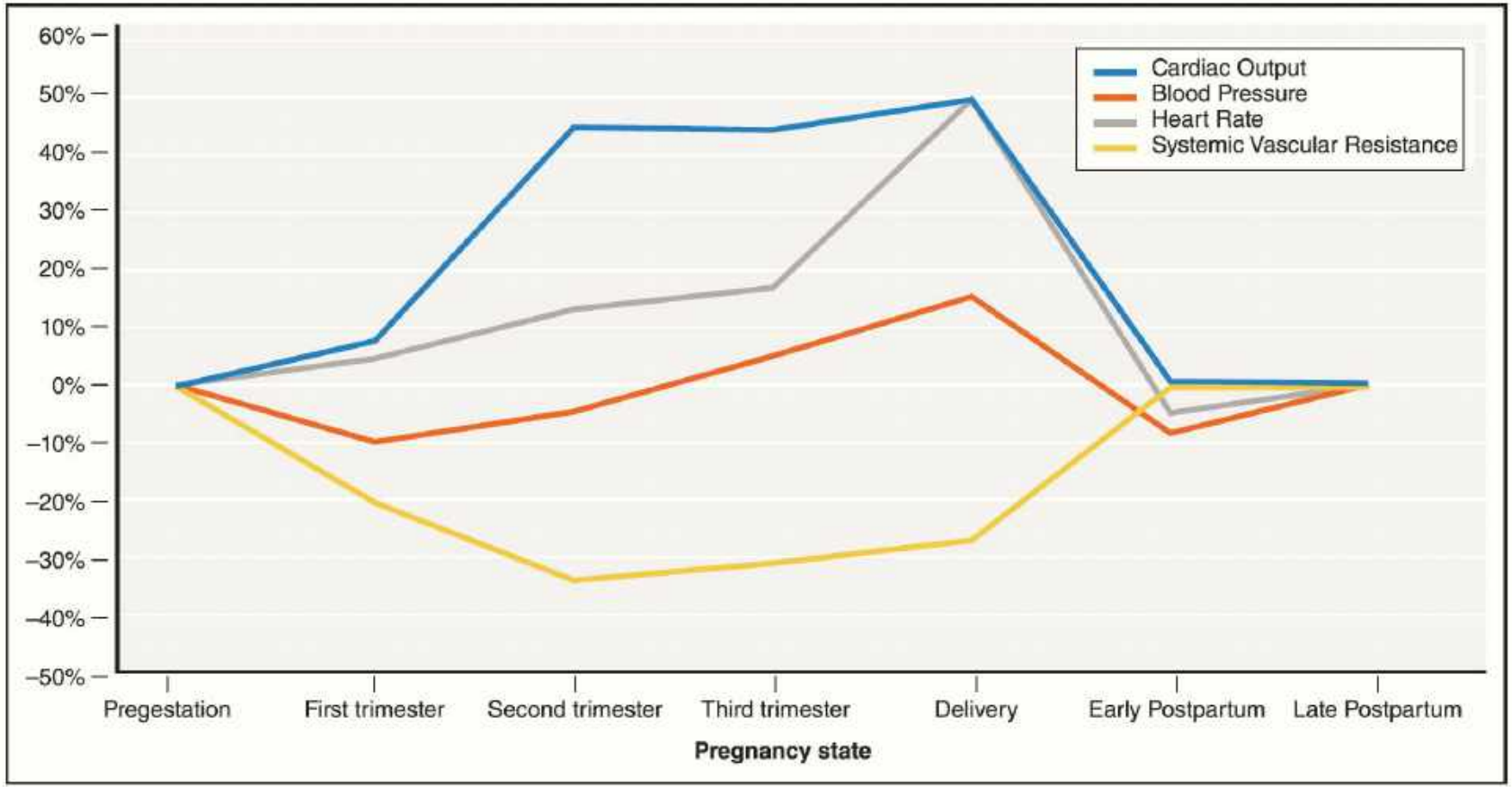
Postpartum



Postpartum

- Cardiac output increases by 60-80% in immediate ppt
- Rapidly dec. in the first 10 mins
- Back to normal values within 1 hr

- Auto-transfusion
- Fluid retention



Mehta et al 2020

2

RISK ASSESSMENT

Who is likely to have complications?

My patient

32yo G1 woman at 16 weeks GA

Clinical diagnoses:

- Post arterial switch
- Circumflex artery arising from the right coronary artery
- Moderate neo-aortic regurgitation
- Dilated proximal ascending aorta (mild)
- Right ventricular dilatation (mild)
- Reduced RV systolic function (mild)
- Left ventricular dilatation (mild)
- LV systolic dysfunction (mild)
- NSVT (2019)

Risk assessment

- What is the diagnosis?
- How well does the patient tolerate physical activity?
- Does the patient have any poor prognostic factors?

mWHO classification of maternal CV risk

ESC Guideline 2018

mWHO classification of maternal CV risk

	Cardiac event rate	Conditions
Class 1	2.5-5%	Mild pulm stenosis, small PDA, mild mitral valve prolapse. Successfully repaired ASD, VSD, PDA, anomalous pulm venous drainage. Isolated PACs and PVCs.
Class 2	5.7-10.5%	Unrepaired ASD or VSD. Repaired Tetralogy of Fallot Supraventricular arrhythmias. Turner syndrome without aortic dilatation.
Class 2-3	10-19%	Mild LV impairment w/ EF > 45%. HCM. Mild mitral stenosis. Moderate aortic stenosis. AVSD. Repaired coarct. Marfan or other HTAD syndrome w/o aortic dissection. BAV with aorta <45mm
Class 3	19-27%	LVEF 30-45%. Prev PPCM w/o residual LV impairment. Mechanical valve. Systemic RV with good fxn. Uncomplicated Fontan. Unrepaired cyanotic CHD. Other complex CHD. Mod MS. Severe asymptomatic AS. Marfan/HTAD w/ Ao 40-45mm. BAV w/ Ao 45-50mm. Turner w/ ASI 20-25 mm/m^2. Ventricular tachycardia.
Class 4	40-100%	Pulmonary arterial htn. Severe LV dysfunction (LVEF <30%, NYHA class 3/4), PPCM with residual LV impairment. Severe MS. Severe symptomatic AS. Systemic RV with mod-severe dec fxn. Marfan/HTAD w/ Ao >45mm, BAV w/ Ao >50mm, Turner w/ ASI >25mm/m2. Vascular EDS. Severe coarctation. Fontan with complications.

mWHO classification of maternal CV risk

	Conditions
Class 4	Pulmonary arterial hypertension Severe mitral stenosis Severe symptomatic aortic stenosis Severe LV dysfunction (LVEF <30%, NYHA class 3/4) Peripartum cardiomyopathy with residual LV impairment Systemic RV with mod-severe decreased function Marfan/heritable thoracic aortic disease with Aorta >45mm Bicuspid aortic valve with Aorta >50mm Turner syndrome with Aortic size index >25mm/m^2 Vascular Ehlers-Danlos syndrome Severe coarctation of the aorta Fontan with complications

NYHA functional class

Class	Symptoms
I	No limitation in normal physical activity.
II	Mild symptoms only in normal activity.
III	Marked symptoms with daily activity. Asymptomatic only at rest.
IV	Severe limitations. Symptoms even at rest.

Poor prognostic factors

- Prior cardiac event
  - Heart failure, TIA, stroke, arrhythmia
- Pulmonary hypertension
- Mechanical valves
- Cyanosis, O_2 sat < 90%
- Systemic ventricle EF <40%
- Subpulm ventricle w/ reduced fxn

- Mod-severe AV valve regurg
- Mod-severe left heart obstruction
- Repaired or unrepaired cyanotic heart disease
- NYHA class III or IV
- Cardiac medications before preg
- NT-proBNP >128 pg/mL <20 wks GA

Risk assessment

Which is more concerning?

Patient A:

A small unrepaired VSD with left to right shunting. Otherwise normal echo. Normal exercise tolerance. No previous cardiac events.

Patient B:

Severe aortic stenosis with a bicuspid aortic valve. Angina with mild physical activity. NYHA class III.

Risk assessment

Which is more concerning?

Patient A:

A large VSD with moderate left to right shunting. LV appears dilated on echo. Unable to tolerate brisk walking or stair climbing. Had heart failure 3 months ago, treated medically.

Patient B:

Moderate aortic stenosis with a bicuspid aortic valve. Asymptomatic. Otherwise normal echo. No previous cardiac events.

3

INTRAPARTUM MANAGEMENT

Delivery planning

- When?
- Where?
- How?
- Anesthesia
- Monitoring
- Equipment and expertise
- Endocarditis prophylaxis
- Anticoagulation

Timing

- Usually routine practice
- Consider: distance from hospital, course of pregnancy, cessation of anticoagulation
- **ESC 2018:** Consider delivery by 40 weeks. In the general population, this reduces emergency CS and stillbirth.

Location

- Available infrastructure
  - Telemetry (ECG)
  - ICU, CCU
  - In-house cardiology and anaesthesia
  - Access to CV surgery, ECLS
- Recommendation of local team

Monitoring

- Telemetry (Continuous ECG)
  - If at risk of arrhythmia
- ART line for accurate BP
- Swan-Ganz – rarely useful
  - Consider in severe pulm htn
- FH monitoring

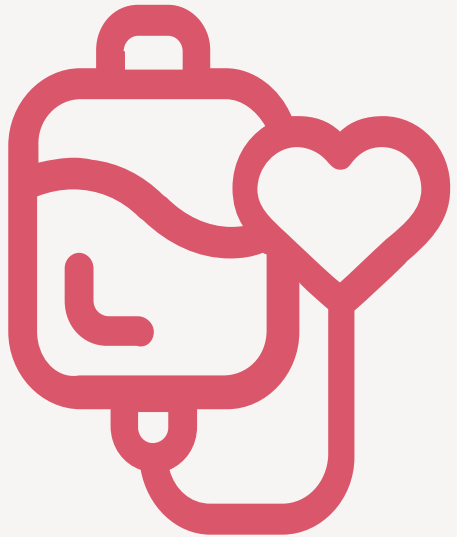
Telemetry

Indications

- Prior cardiac arrest
- PVCs > 10%
- Symptomatic NSVT > 3 beats
- Heart block
- Pre-excited atrial fibrillation
- WPW with syncope
- EF < 40% and syncope

Fluids

- Some are at risk of heart failure -> limit IV fluids
  - Mitral stenosis
- Some are preload dependent -> need adequate volume
  - Aortic stenosis
- Modify your infusion rates



Lee et al 2021

Induction of labour

Lee et al 2021

Induction of labour

Cervical foley

- Safe

Low dose misoprostol (< 800mcg)

- Safe

Dinoprostone (Prostin gel, Cervidil)

- Safe

Induction of labour

Oxytocin

- Safe at the dosing used for IOL
- Can cause fluid retention
- Risk of heart failure/pulmonary edema in susceptible individuals.
    - Favour misoprostol in these cases.

Endocarditis prophylaxis

- Annual incidence of endocarditis
  - CHD: 1 in 1,000
  - Prosthetic valves: 3-12 in 1,000
- Prophylaxis is NOT recommended during delivery (AHA, ECS)
- If administering, give 30 mins before anticipated delivery

Endocarditis prophylaxis

Indications	Antibiotic regimen
Prosthetic valve, or valve repair w/ prosthetic material	Amoxicillin 2g PO
Previous endocarditis	Ampicillin 2g IV
Unrepaired cyanotic CHD, including palliative shunts and conduits	Pen allergic: Cephalexin 2g PO
CHD completely repaired < 6 mos ago with prosthetic material or device.	Pen allergic: Azithromycin 500mg PO
Repaired CHD with residual defect next to prosthetic material.	Pen allergic: Cefazolin 1g IV
Cardiac transplant w/ valvulopathy	

Mode

Elkayam et al 2016

Labour

- Oxygen consumption increases x3
- Blood pressure increases
- **Cardiac output increases**
  - First stage - 30%
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Mode

- What about a planned c-section?

Planned c-section

Ruys et al 2015

- Retrospective
- Enrolled women with CHD, valvular heart disease, cardiomyopathy, ischemic heart disease
- 2008-2011
- Group 1: Planned CS for OB or cardiac reasons (n=393)

Planned c-section

Ruys et al 2015

Planned CS vs planned VD

- No difference in perinatal mortality or APGAR
- GA and birthweight lower in CS group

Actual CS vs actual VD

- No difference in:
  - Parental mortality (1.8 vs 1.5%, p = 1.0)
  - PPT heart failure (8.8 vs 8.2%, p = 0.79)

Planned c-section

ESC recommends considering CS for:

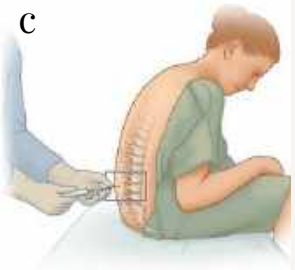
- **Labour while on warfarin**
- Ascending aortic diameter > 4.5 cm
- Marfan and aortic diameter > 4.0 cm
- Severe aortic stenosis
- Eisenmenger’s syndrome
- Severe heart failure

What are two interventions that lessen the increase in cardiac output that occurs in labour?

a

b

c



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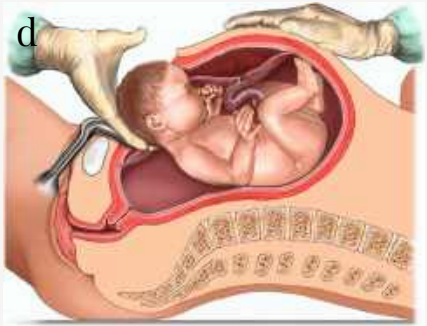

e

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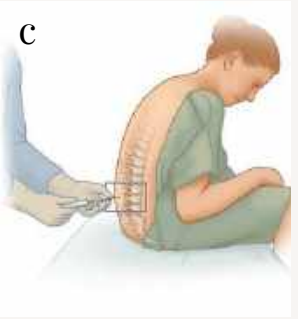
What are two interventions that lessen the increase in cardiac output that occurs in labour?

c



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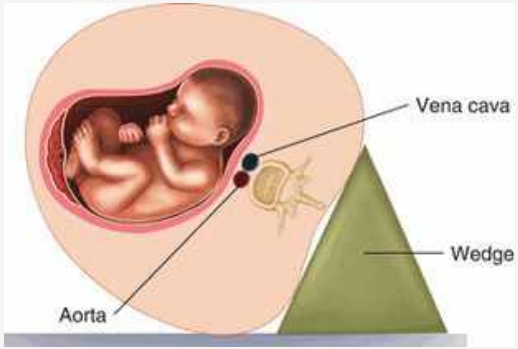


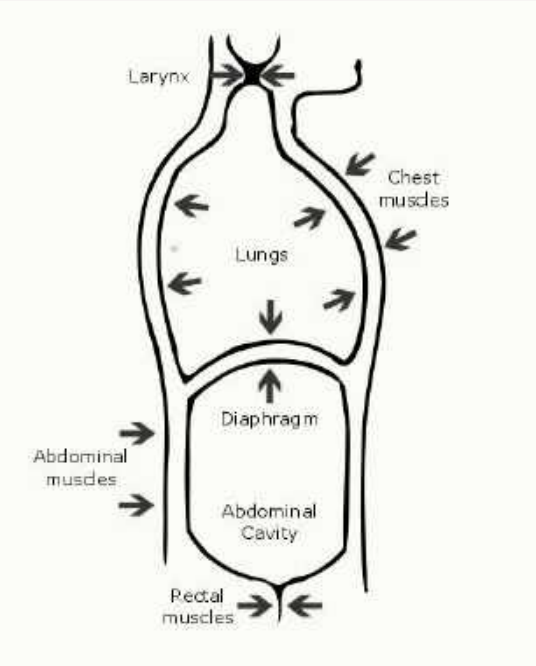
Venocaval compression

- After 24 weeks, the uterus puts significant compression on the IVC when supine
- Decreases venous return and cardiac output by up to 30%

Analgesia

- Epidural analgesia lessens the increase in CO during labour
- Risk of hypotension – 10%
- When hypotension is risky, titrate epidural slowly and avoid single shot spinal:
  - Obstructive valve lesions
  - HOCM with LVOT obstruction

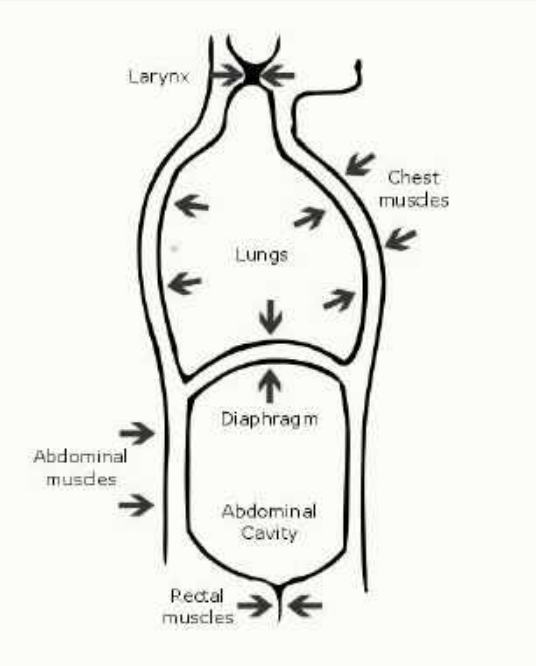
Second stage



Canobbio et al 2017

Pushing

- Dec venous return
- Dec preload
- Dec cardiac output
- Increased aortic pressure
- Dec heart rate

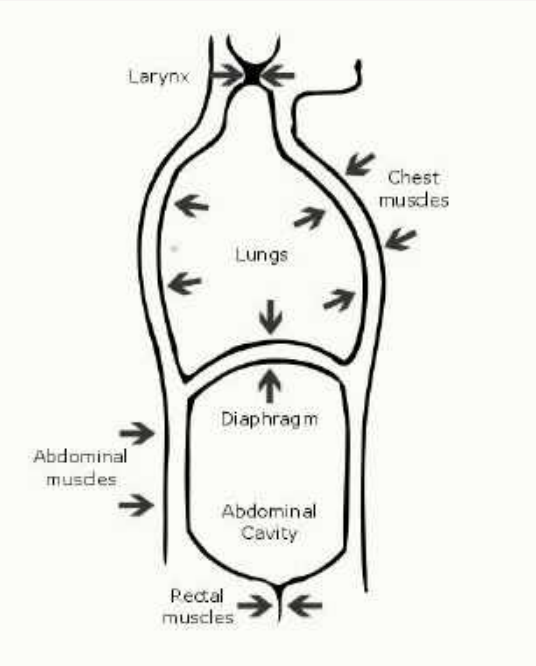


Canobbio et al 2017

Pushing

Problematic for:

- Preload dependent conditions
- Intolerant of inc aortic pressure/hypertension



Canobbio et al 2017

Pushing

Caution in:

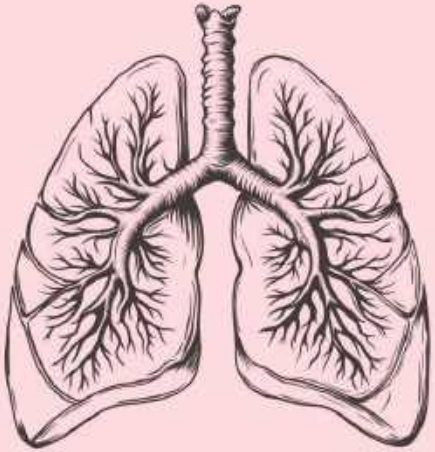
- Severe aortic stenosis
- Severe mitral stenosis
- Pulmonary hypertension
- Fragile aorta (aortopathy, CTD)
- NYHA class III or IV

Severe aortic stenosis

- Aortic valve is narrow = high afterload
- To maintain cardiac output, the heart relies on adequate preload
- Valsalva can decrease preload
- Can benefit from being on the “wetter” side in labour
- Cannot meet the demand for increased

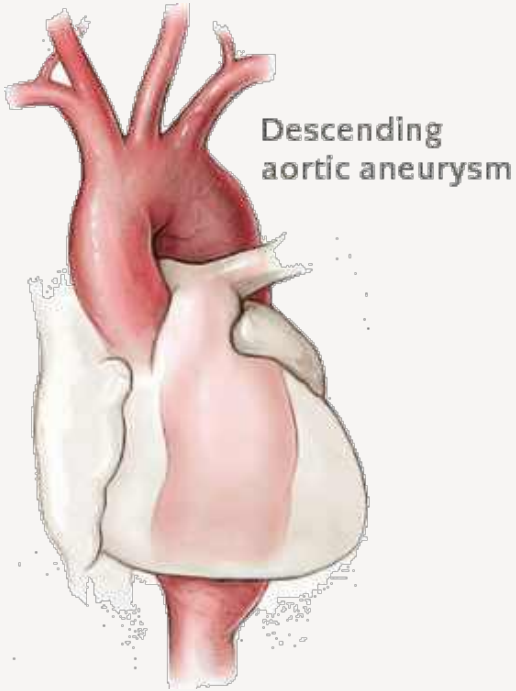
Severe mitral stenosis

- Mitral valve is narrow
- LV filling, and therefore cardiac output, are impaired due to reduced inflow
- Valsalva can further reduce LV filling
- Also at high risk of heart failure, pulmonary edema and atrial fibrillation
- Avoid fluid overload



Pulmonary hypertension

- Increased pressure in pulmonary vasc.
- Hard for RV to get blood into the lungs
- Euvolemia required
- Valsalva decreases preload, which reduces perfusion to the lungs -> RV failure
- Hypotension is also life-threatening, as it can cause RV ischemia



Dilated aorta

- Valsalva increased aortic pressure
- May increase risk of dissection

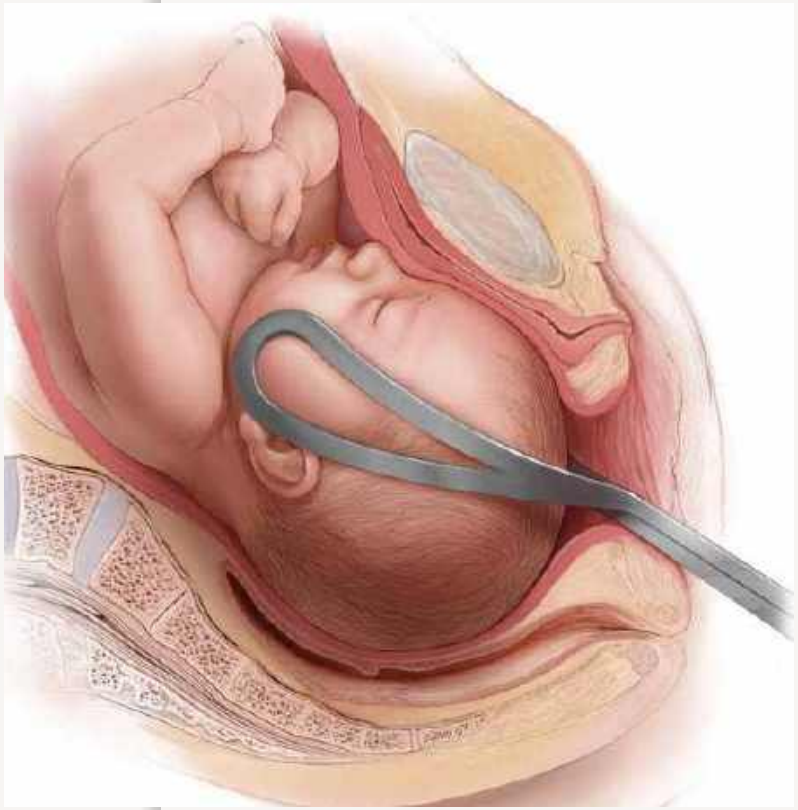
Second stage

- Prolong the passive second stage to allow for descent of fetal head
- Optimize position

Assisted second stage

Consider in:

- Severe aortic stenosis
- Severe mitral stenosis
- Severe pulmonary hypertension
- Fragile aorta (aortopathy, CTD)
- Severely reduced LVEF
- Poor exercise tolerance, NYHA class



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POSTPARTUM MANAGEMENT

PPH management

Lee et al 2021

PPH management

Oxytocin

- Rapid IV bolus (5-10u) causes a drop in SVR and hypotension
  - Myocardial ischemia
  - QT prolongation
- Slow and small doses have less impact (ex: 2 units over 10 mins)

Avoid rapid IV dosing in:

Lee et al 2021

PPH management

Carbetocin

- A long-acting synthetic oxytocin
- 100mcg of carbetocin has similar effects as 5u IV of oxytocin
- Not studied in the cardiac population

Lee et al 2021

PPH management

Ergometrine (Ergot)

- Systemic and pulmonary vasoconstriction
- Coronary vasoconstriction
- Hypertension

Avoid in:

- Pulmonary hypertension, aortopathy,

  cyanotic heart disease, coronary artery disease, severe valvular disease, left heart

Lee et al 2021

PPH management

Carboprost (PG F2α, Hemabate)

- Systemic and pulmonary vasoconstriction at high doses

Avoid in:

- Pulmonary hypertension
- Cyanotic heart disease
- Pulmonary edema

Lee et al 2021

PPH management

High dose misoprostol (≥ 800mcg)

- Hypotension
- Coronary vasospasm

Avoid in:

- Pulmonary hypertension
- Coronary artery disease
- Significant valvular disease

PPH management

- Depends on the lesion
- Favour slow, small doses of oxytocin, and carbetocin
- Miso 200mcg SL is safe
- Carboprost is 3rd line
- Avoid ergot in most cases
- If patient has contraindications to most

Postpartum considerations

Postpartum considerations

- A high-risk time for heart failure
- Especially high risk for some conditions
  - Marfan: aortic dissection
  - Mitral stenosis: heart failure
  - LQTS: sudden cardiac death

Postpartum considerations

- Monitored setting
  - CCU, ICU, L&D, postpartum floor
- Diuresis
  - For those at risk of, or in heart failure
- Telemetry
  - For those at risk of arrhythmia
- Anticoagulation
  - For those at risk of thrombosis

The neonate

- Genetic testing from cord blood
- If exposed to beta blockers: Monitor sugars and HR
- Exam by Paeds
- ECG
    - If at risk of channelopathy (Long QT syndrome, Brugada syndrome)
- Echo
    - If not done during pregnancy, or abnormalities suspected

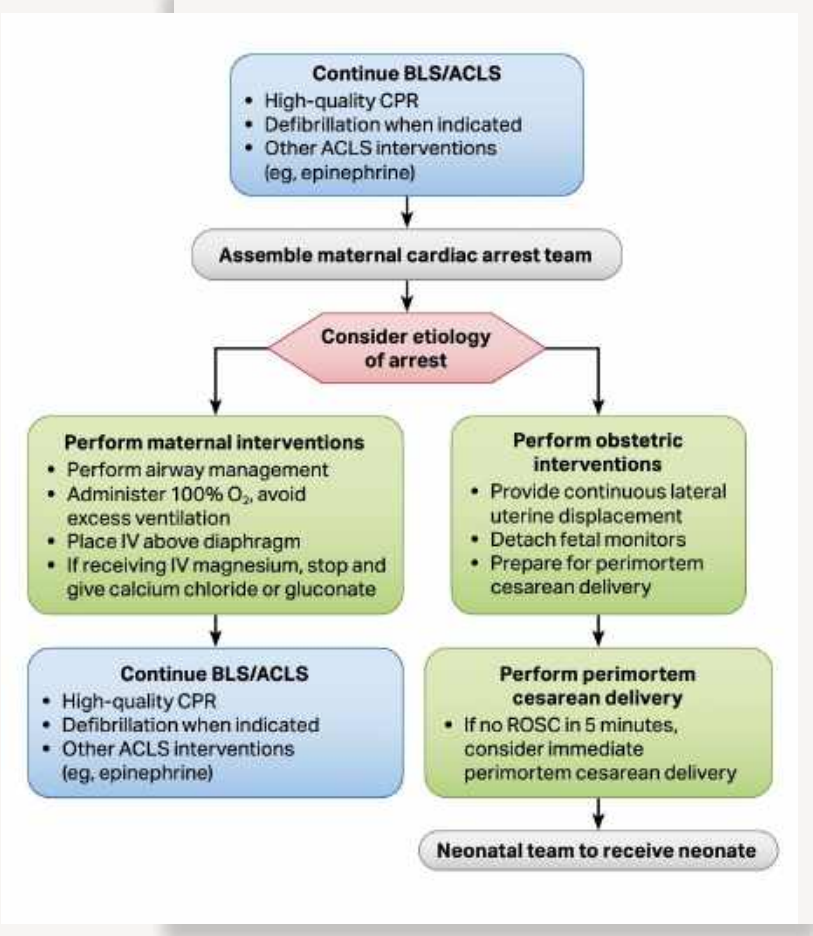
5

PERIMORTEM C-SECTION

ACLS in pregnancy

Etiology of cardiac arrest in pregnancy

- **A** Anesthetic complications
- **B** Bleeding
- **C** Cardiovascular
- **D** Drugs
- **E** Embolic
- **F** Fever
- **G** General non-OB causes (H's & T's)
- **H** Hypertension



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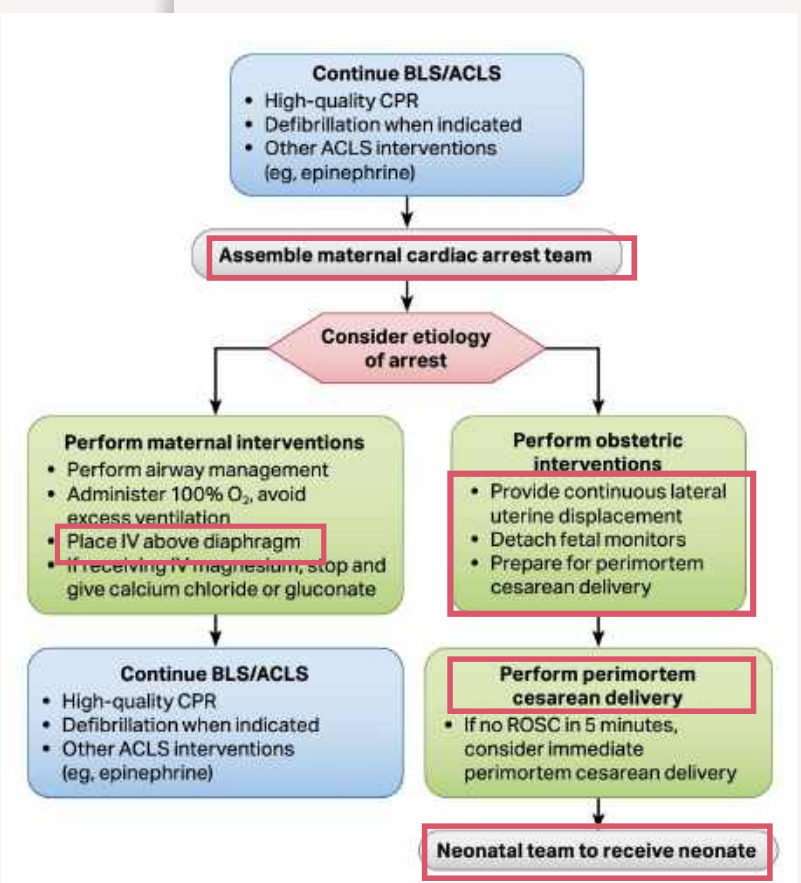
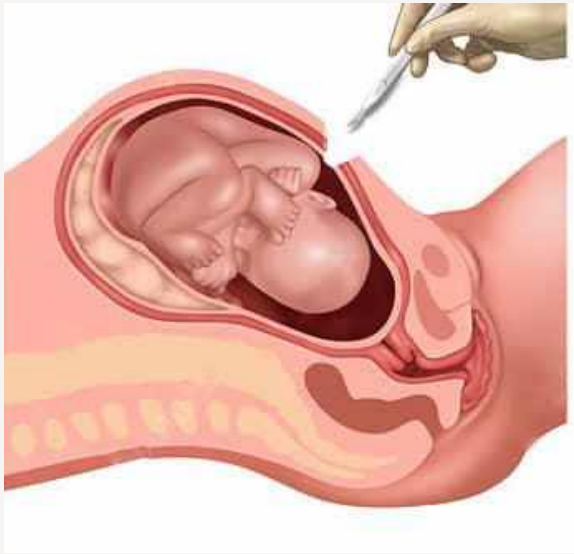


Perimortem CS

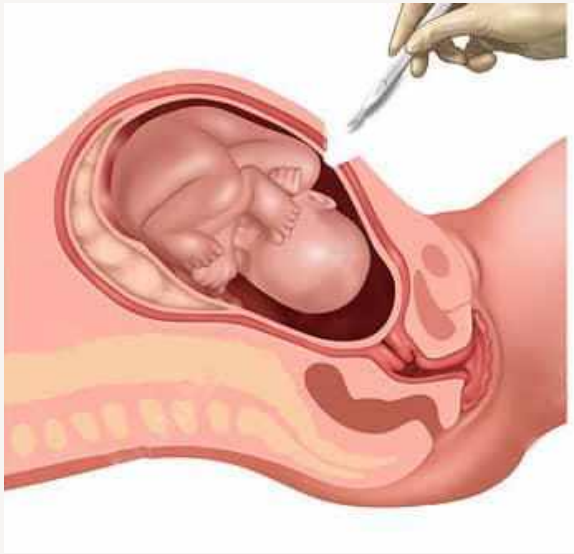
- Done in the context of parental cardiac arrest
- Goal: improved parental resuscitation
- Secondary goal: fetal survival
- Done after 24 weeks, once uterine compression of IVC is significant
- Initiate within 4 mins of cardiac arrest
- Done at bedside



Perimortem CS

If a patient is at high risk of cardiac arrest:

- Offer options (TOP, early delivery)
- Admit to hospital
- Discuss fetal goals of care (viability, resuscitation plan)
- Equipment ready near patient's room
- All teams aware
- Consistent handover
- Detailed care plan



6

TAKEAWAYS

- A heterogenous group of conditions
- Each patient requires an individualized approach
- Requires a multidisciplinary approach
- Risk assessment is invaluable
- Careful delivery planning required

7

RESOURCES

European Society of Cardiology guidelines- 2018

ESC
European Society of Cardiology
European Heart Journal (2018) **39**, 3165–3241
doi:10.1093/eurheartj/ehy340

ESC GUIDELINES

2018 ESC Guidelines for the management of cardiovascular diseases during pregnancy

The Task Force for the Management of Cardiovascular Diseases during Pregnancy of the European Society of Cardiology (ESC)

State-of-the-art review - 2016

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http://dx.doi.org/10.1016/j.jacc.2016.05.050

THE PRESENT AND FUTURE

STATE-OF-THE-ART REVIEW

High-Risk Cardiac Disease in Pregnancy

Part II

Uri Elkayam, MD,[a] Sorel Goland, MD,[b] Petronella G. Pieper, MD,[c] Candice K. Silversides, MD[d]

Arrhythmias in pregnancy guideline - 2023

NEWS FROM THE HEART RHYTHM SOCIETY

2023 HRS expert consensus statement on the management of arrhythmias during pregnancy

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