Oh Mother!

Overview of Obstetric Emergencies Managed in the Intensive Care Unit

A presentation for HealthTrust Members
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Objectives

- Recall incidence, risk factors and pathophysiology of obstetric emergencies that can complicate pregnancy, childbirth and the post-partum period.
- Identify therapeutic strategies to manage common obstetric emergencies.
- Recognize pharmacologic considerations for pregnant and post-partum patients requiring advanced cardiac life support (ACLS).

Abbreviations

- AFE: Amniotic Fluid Embolism
- CPR: Cardiopulmonary resuscitation
- CS: Cesarean section
- CXR: Chest X-ray
- DBP: Diastolic blood pressure
- EBL: Estimated blood loss
- ECHO: Echocardiogram
- ECMO: Extracorporeal membrane oxygenation
- FDA: Federal Drug Association
- LFTs: Liver function tests
- OBER: Obstetric emergency room
- OR: Operating room
- PE: Pulmonary embolism
- PRBCs: Packed red blood cells
- PPH: Post-partum hemorrhage
- pVT: Persistent ventricular tachycardia
- RV: right ventricle
- SBP: Systolic blood pressure
- SCr: Serum creatine
- VA ECMO: Veno-arterial ECMO
- VF: Ventricular fibrillation
- VV: Veno-venous

Overview of Obstetrics

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Obstetric Emergencies

- Rare, yet severe complication of pregnancy and postpartum
  - <1% of all Intensive Care Unit (ICU) admissions
  - <1% of all pregnancies
  - Maternal mortality is 17.3 deaths per 100,000 live births
- Must consider the physiologic and pharmacologic adaptations in pregnancy that differ from the general population
- Clinical pharmacists play a vital role in designing and managing a pharmacologic plan
- Potential obstetric emergencies seen in the ICU

Acute fatty liver of pregnancy	**Amniotic fluid embolism**	**HELLP Syndrome**
Ovarian hyperstimulation syndrome	Peripartum cardiomyopathy	**Preeclampsia**
Post-partum hemorrhage	Tocolytic-induced pulmonary edema	**Eclampsia**

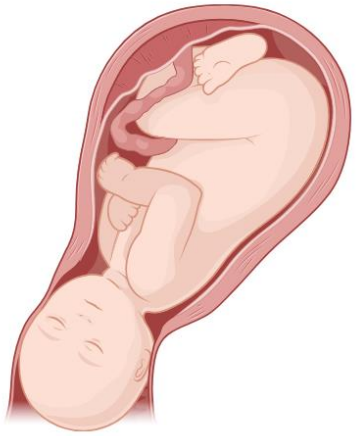
Source: Baltaji et al., 2023; Kelsey et al., Pollack et al., 2010

Peripartum & Postpartum Terminology

- Gestational age: length of the pregnancy in weeks
- First trimester: conception – week 13
- Second trimester: week 13 – 28
- Third trimester: week 28 – 40
- Postpartum: delivery – 6 weeks

Three Stages of Labor and Delivery

Stage 1
Contractions



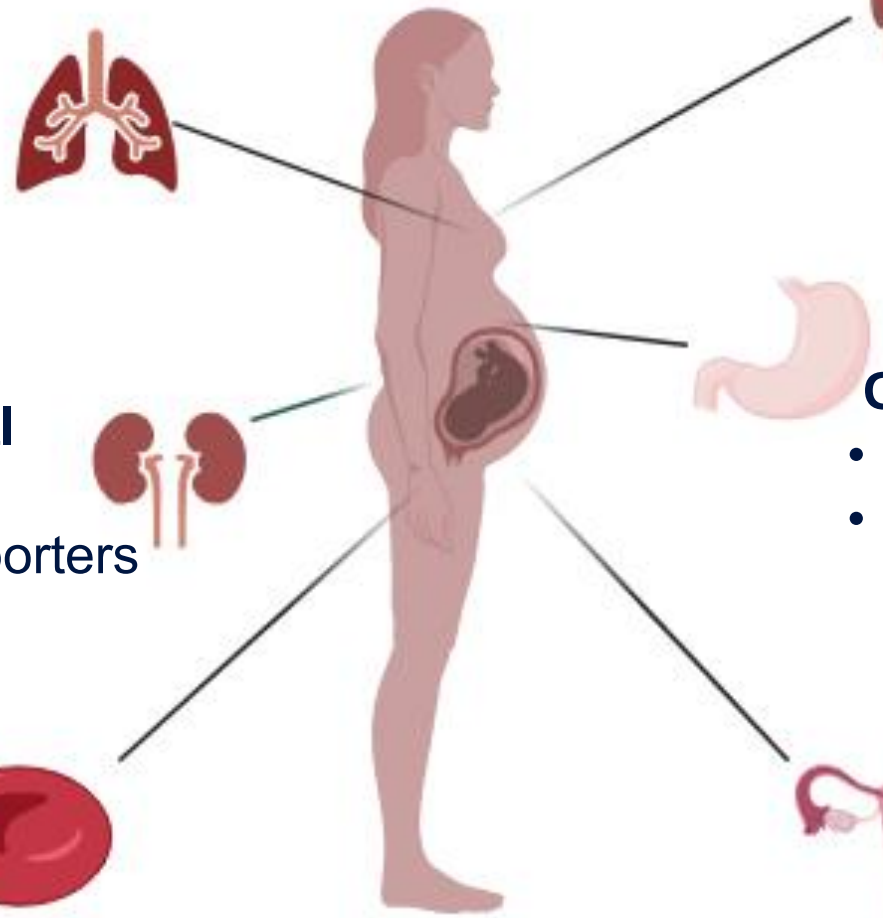
Stage 2
Crowning

Stage 3
Delivery of placenta

Source: ACOG, 2013

Physiologic Considerations During Pregnancy

Pulmonary
- ↑ tidal volume
- ↑ minute ventilation
- ↑ oxygen consumption
- ↓ residual capacity
- Respiratory alkalosis



Cardiovascular
- ↑ cardiac output
- ↓ blood pressure
- ↓ systemic volume resistance

Renal
- ↑ blood flow
- ↑ renal transporters

Gastrointestinal
- ↓ gastric motility
- ↑ gastric pH

Hematologic
- ↑ blood volume by 50%
- ↑ plasma volume

Uteroplacental
- ↑ uterine hypertrophy
- ↑ progesterone
- ↑ estrogen

Source: Baltaji et al., 2023; Kelsey et al.,

Pharmacotherapy Considerations in Pregnancy

Pharmacokinetic properties are altered by several mechanisms in pregnancy

Property	Overall Effect	Mechanism	Effect on Concentration
Absorption	↓	• Prolonged gastric motility by progesterone • Increased gastric pH	↓ (oral drugs (PO))
Distribution	↑	• Increase in blood volume causes dilution of proteins, thereby decreasing protein-bound drugs • Increase in body fat stores • Decrease in albumin/ a1-acid glycoprotein	↓ hydrophilic drugs ↑ lipophilic drugs ↑ for protein bound drugs
Metabolism	↓	Changes in select CYP450 enzymes (CYP1A2 and CYP2C19)	Variable
	↑	Increased hepatic flow	↓
Elimination	↑	Increased renal blood flow and increased renal transporters involved in secretion	↓

Source: Eke et al., 2023

Pharmacotherapy Considerations in Pregnancy

Fetal risk considerations

- Drugs enter placenta from maternal circulation via diffusion and influx transporters
  - Drug characteristics that increase movement into placenta
    - Non-ionized
    - Nonprotein-bound
    - Low molecular weight
    - High lipophilicity
- Teratogenic drugs unlikely to cause malformations after 12 weeks as embryogenesis mostly complete
- Drugs causing fetal toxicity may occur in late pregnancy

Teratogenic drugs
Warfarin
Phenytoin
Corticosteroids
Drugs causing fetal toxicity
ACE-Inhibitors

Source: Heavner et al., 2023

Patient Case #1

Patient Case #1

H&P

31 year-old who is 35 weeks of gestation presents to OBER with severe headache, blurry vision and mild upper abdominal pain. Patient given magnesium sulfate and IV labetalol and admitted for delivery.

Labs & Vitals Upon Admission

BP	160/102 mmHg
Platelets	130 x 10^9/L
AST	85 U/L
SCr	1.1 mg/dL
Protein:SCr	0.3
CXR	Pulmonary edema

Patient Case

Infant urgently delivered via CS delivery for **preeclampsia with severe features**

At skin closure, patient complained of severe headache and upper quadrant pain then began exhibiting tonic-clonic seizure activity concerning for **eclampsia**. BP was 201/175 mmHg

Patient intubated for ongoing seizure activity; magnesium sulfate, midazolam and IV hydralazine administered

Labs remarkable for **HELLP syndrome**; Platelets 58 x 10^9/L; AST 620; ALT 590; LDH 950; INR 1.6.

Platelets and fresh frozen plasma administered

Patient stabilized in the ICU, labs normalized and patient discharged home 9 days later

Preeclampsia

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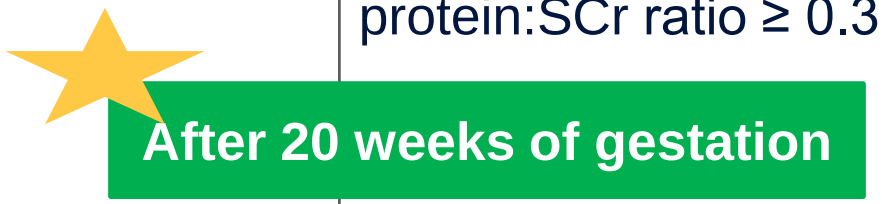
Preeclampsia

Epidemiology

- Occurs in 6% - 8% of pregnancies
- Maternal mortality due to hypertensive disorders occurs in up to 16%

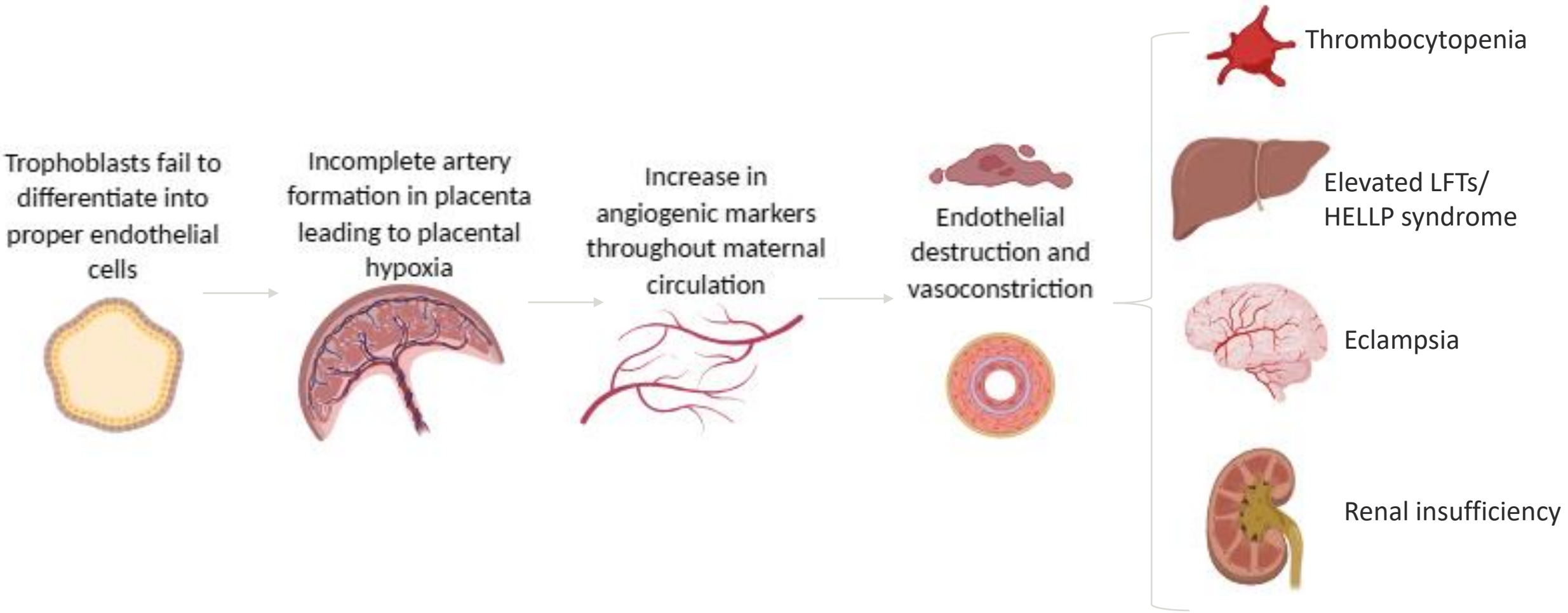
Definitions

Gestational Hypertension	Preeclampsia	Severe Features
•SBP ≥ 140 or DBP ≥ 90 mmHg on 2 occasions at least 4 hours apart •SBP ≥ 160 or DBP ≥ 110 mmHg	Gestational hypertension + proteinuria* or severe features *≥300 mg/d urine collection or protein:SCr ratio ≥ 0.3	•SBP ≥ 160 or DBP ≥ 110 mmHg on 2 occasions at least 4 hours apart •Platelets < 100 x 10^9/L •Elevated LFTs x 2 upper limit normal •New onset headache •SCr ≥ 1.1 mg/dL •Pulmonary edema



Source: ACOG Practice Bulletin et al., 2020

Preeclampsia Pathophysiology



Source: Ives et al., 2020

Preeclampsia Management

Management Goal

To prevent progression of preeclampsia to eclampsia, HELLP syndrome and other complications

Prevention

- Aspirin 81 mg daily
  - Initiated between 12 and 28 weeks gestation through delivery
  - In patients with at least 1 high risk factor or more than 1 moderate risk factor

High Risk	Moderate Risk
History of preeclampsia	Obesity
Multifetal gestation	Age greater than 35
Chronic hypertension, diabetes, autoimmune disease, renal disease	Family or personal history factors
	Sociodemographic factors

Delivery versus Expectant Management

- Timely delivery best prevention for progression to eclampsia
- Certain populations may benefit from expectant management with strict observation

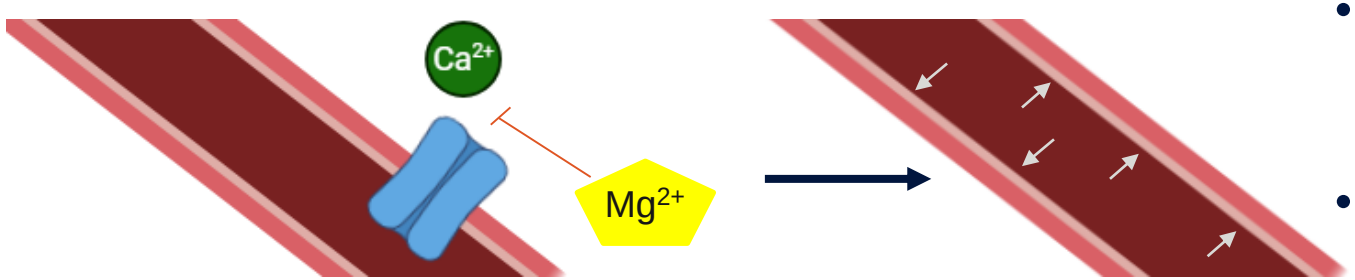
Source: ACOG Practice Bulletin et al., 2020

Magnesium Sulfate

Indication

- Seizure prophylaxis in preeclampsia with severe features; risk versus benefit discussion in preeclampsia without severe features

Mechanism of Action



- Magnesium blocks calcium channels in the vascular smooth muscle resulting in vasodilation
- Anticonvulsive property likely due to inhibiting N-methyl-D-aspartate receptors

Regimen

- 4 – 6 g IV loading dose (LD) over 20 – 30 min, followed by maintenance dose of 1 – 2 g/hour for 24 hours after delivery
- 10 g IM LD (5 g IM each buttock), followed by 5 g IM every 4 hours.

Source: Bartel et al., 2022; ACOG Practice Bulletin et al., 2020

Magnesium Sulfate

MAGPIE Trial	
Design	Randomized, placebo controlled international trial
Intervention	Magnesium sulfate ($MgSO_4$) 4 g IV LD over 15 min, followed by 1 g/h IV infusion for 24 hours versus placebo
Inclusion	Pregnant woman or <24 hours postpartum, BP ≥ 140/90 mmHg ≥ 2 occasions, proteinuria, clinical uncertainty about administering magnesium sulfate
Outcome	Primary: Eclampsia or, in pregnant mothers, death of infant Secondary: Maternal morbidity, toxicity requiring discontinuation or calcium gluconate
Population	10,141 patients from 33 countries; $MgSO_4$, n=5068 and placebo, n=5068 - Baseline characteristics did not differ - Mean age 27 years - 16% had SBP > 170 mmHg at entry - 13% were postpartum at randomization

Source: The Magpie Trial Collaborative Group, 2002

Magnesium Sulfate

<table>
<tr><th colspan="2">MAGPIE Trial</th></tr>
<tr><td>Primary Outcome</td><td>- ↓ eclampsia in $MgSO_4$ group (n=40, 0.8%) vs placebo (n=96, 1.9%) (p<0.0001)
- No difference in infant death (576 (12.7%), vs 558 (12·4); 95% CI –8% to 14%)</td></tr>
<tr><td>Secondary Outcome</td><td>
<table>
<tr><th>Characteristic</th><th>$MgSO_4$,n=5055</th><th>Placebo, n=5055</th></tr>
<tr><td>Any morbidity</td><td>196 (3.9%)</td><td>183 (3.6%)</td></tr>
<tr><td>Respiratory depression</td><td>46 (0.9%)</td><td>27 (0.5%)</td></tr>
<tr><td>Calcium gluconate</td><td>14 (0.3%)</td><td>11 (0.2%)</td></tr>
</table>
</td></tr>
<tr><td>Critique</td><td>- Large trial suggesting benefit of $MgSO_4$ to decrease risk of eclampsia
- Greater difference in low-income countries
- No subgroup analysis of severe features versus no severe features
- Serum concentrations not disclosed</td></tr>
</table>

Source: The Magpie Trial Collaborative Group, 2002

Magnesium Sulfate

Monitoring

- Obtain magnesium levels every 4 – 6 hours in renal dysfunction or signs of toxicity
- Respiratory status
- Tendon reflexes

Adverse Events

- Result from smooth muscle relaxation
- Correlated with elevated serum concentrations and higher infusion rates
- Accumulation occurs in renal function

Magnesium sulfate side effects and toxicity		
Symptom	**mEq/L**	**mmol/L**
Therapeutic range	4 – 7	2 – 3.5
Loss of tendon reflex	>7	>3.5
Respiratory depression	>10	>5
Cardiac arrest	>25	>12.5

Management of Toxicity

- If magnesium level >8mEq/L, stop infusion and recheck every 2 hours until magnesium <7mEq/L
- Respiratory depression may require intubation
- Emergency correction with calcium gluconate 10% IV infusion over 3 minutes

Source: Bartel et al., 2022; ACOG Practice Bulletin et al., 2020

Antihypertensives

- Indicated for acute-severe hypertension: SBP ≥ 160 mmHg and/or DBP ≥ 110 mmHg sustained over at least 15 minutes
- Should be administered within 30 – 60 minutes or as soon as possible
- Prospective study found implementing a standardized approach to treat sustained critically elevated BP decreases incidence of eclampsia by 42.6% and maternal morbidity by 16.7%

Drug	Dose	Onset	Clinical Pearls
Labetalol	10 – 20 mg IV, then 20 – 80 mg every 10 – 30 min for cumulative dose of 300 mg	1 – 2 min	Avoid in decompensated cardiac function, heart block or bradycardia
Hydralazine	5mg IV/IM, then 5 – 10mg IV every 20 – 40 min for cumulative dose 20 mg	10 – 20 min	Tachycardia, tachyphylaxis, abnormal fetal heart rate
Nifedipine (IR)	10 – 20 mg PO, then 10 – 20 mg every 2 – 6 hours for cumulative daily dose of 180 mg	5 – 10 min	Tachycardia, headaches

Source: Shields et al., 2017 ACOG Practice Bulletin et al., 2020

Antihypertensives

Drugs for the treatment of very high blood pressure in pregnancy	
Design	Meta analysis of randomized controlled trials
Intervention	Comparison of one antihypertensive drug to another regardless of dose or route
Inclusion	Women with severe hypertension (SBP ≥ 160 mmHg and/or DBP ≥ 110 mmHg) during pregnancy requiring immediate treatment
Exclusion	Postpartum women
Characteristics of included studies	35 trials including 3,573 patients - Majority of patients had DBP ≥ 110 mmHg and proteinuria or preeclampsia - Agents included hydralazine, calcium channel blockers (CCBs; nifedipine, nimodipine, nicardipine), labetalol, atenolol, methyldopa, magnesium sulfate, prazosin, isosorbide

Source: Duley et al., 2013

Antihypertensives

Drugs for the treatment of very high blood pressure in pregnancy	
Labetalol vs hydralazine	4 trials (269 patients); insufficient data for reliable conclusions
CCB vs hydralazine	6 (313 patients) trials reported less persistent high blood pressure (requiring additional antihypertensive agent) in CCB group vs hydralazine (8% vs 22%, RR 0.37, 95%CI 0.21 – 0.66)
Labetalol vs CCBs	1 trial (50 patients) suggested fewer side effects in nifedipine group than labetalol group (RR 2.17, 95% CI 0.98 – 4.79)
Labetalol vs methyldopa	1 trial (74 patients); insufficient date for reliable conclusions
Isosorbide vs magnesium sulfate	1 trial (36 patients) found no difference in persistent hypertension (RR 0.14, 95% CI 0.01 – 2.58), but less risk of CS delivery in isosorbide group than magnesium sulfate (RR 0.19, 95% CI 0.07 – 0.53)
Conclusion	No clear evidence one agent is preferable over the others, decision should be based on comfortability and availability. Best to avoid magnesium sulfate for its use as an antihypertensive

Source: Duley et al., 2013

Eclampsia

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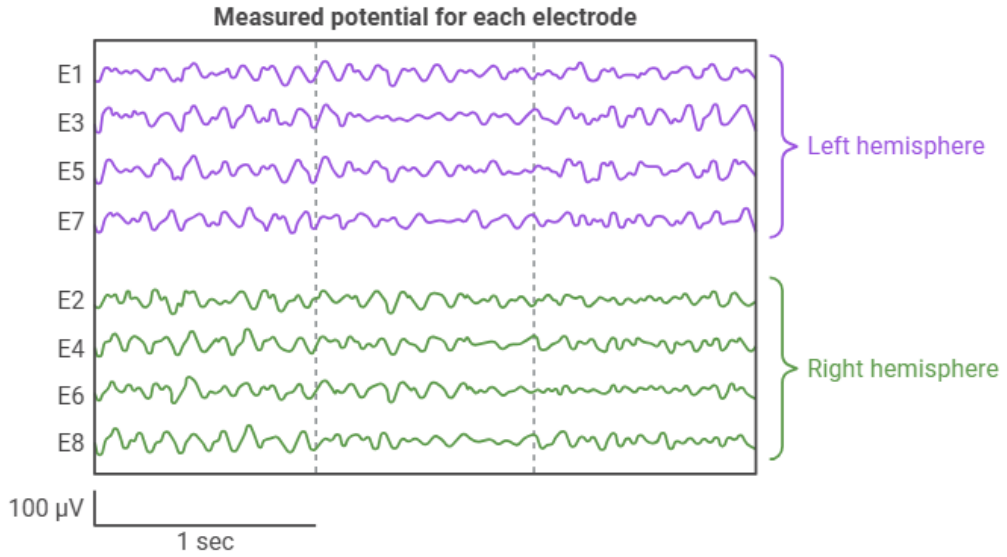
Eclampsia

- Convulsive manifestation of hypertensive disorders in pregnancy in the absence of other causative conditions
- Can occur before, during or after labor



Manifestation

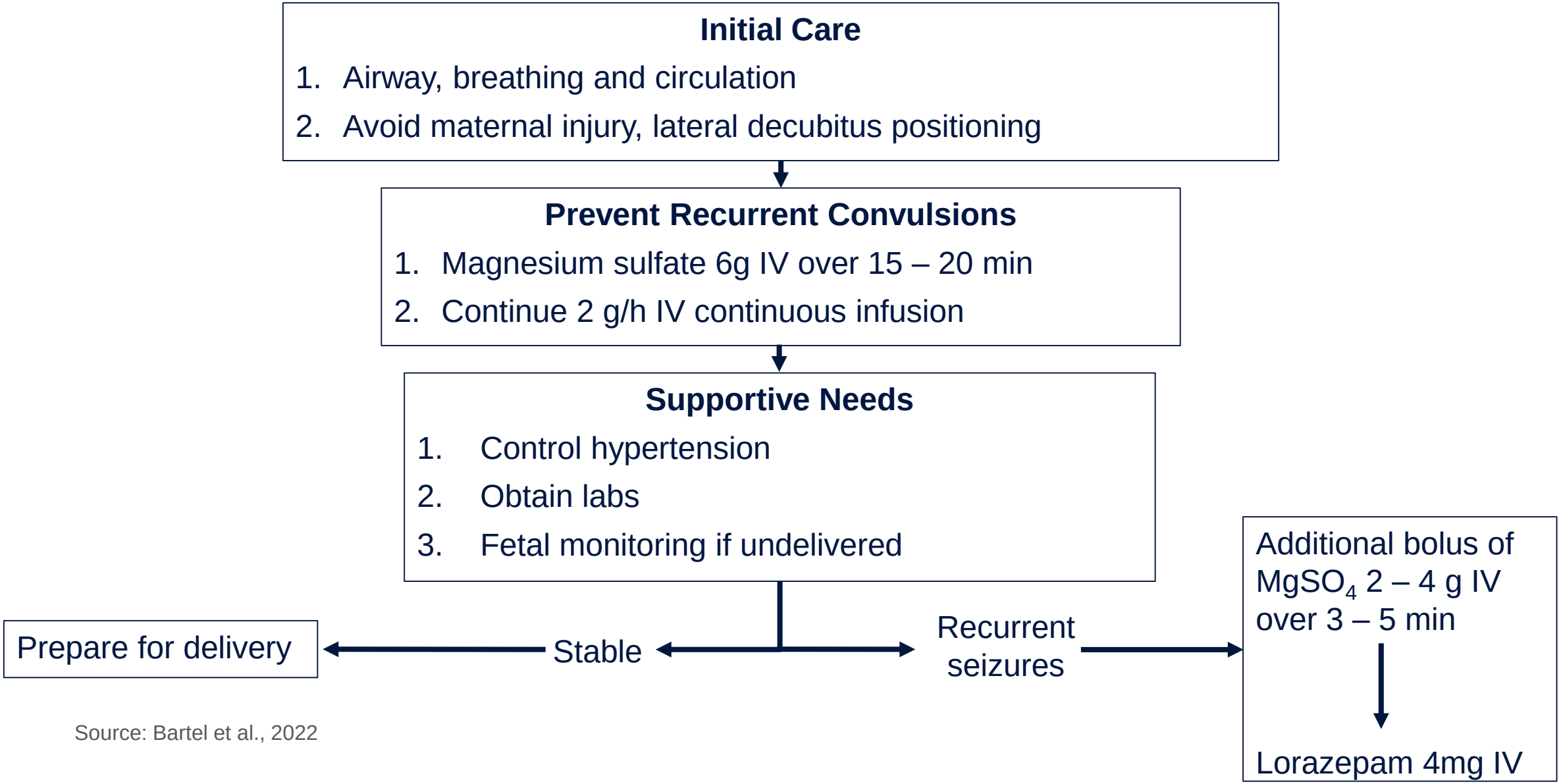
- Up to 80% of cases are preceded by signs
  - Severe headache
  - Blurred vision
  - Altered mental status
- Not all cases of eclampsia are preceded by gestational hypertension or proteinuria

Complications

- Blindness
- Posterior reversible encephalopathy syndrome (PRES)

Source: ACOG Practice Bulletin et al., 2020

Eclampsia Management



Source: Bartel et al., 2022

Magnesium Sulfate versus Antiseizure Medications

Study	Comparator	Population	Outcome
Meta-analysis of pregnant or postpartum patients with eclampsia	Diazepam (10 mg x1, may repeat)	7 RCTs with 1396 patients.	- ↓ maternal death (RR 0.59, 95%CI 0.38 – 0.92) - ↓ recurrence of seizures (RR 0.43, 95% CI 0.33 – 0.55) - No difference in neonatal mortality
	Phenytoin (doses ranged from 15 – 25 mg/kg)	7 RCTs with 970 patients.	- ↓ recurrence of seizures (RR 0.34, 95% CI 0.24 – 0.49) - ↓ ICU admission (RR0.67, 95% CI 0.5 – 0.89) - No difference in maternal mortality.
	Lytic cocktail (chlorpromazine, promethazine, meperidine) (doses varied)	3 trials from India with 397 patients.	- ↓ maternal death (RR 0.14, 95% CI 0.03 – 0.59) - ↓ recurrence of seizures (RR 0.06, 95% CI 0.03 – 0.12)

Source: Duley et al., 2010

HELLP Syndrome

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HELLP Syndrome

Overview

- Hemolysis, elevated liver enzymes, and low platelet count
- Severe form of preeclampsia and associated with high maternal morbidity and mortality

Diagnosis

- Lactate dehydrogenase (LDH): ≥ 600 IU/L
- AST/ALT: ≥ twice the upper limit of normal
- Platelets: ≤ 100 $x10^9$/L

Clinical Presentation

- Right upper quadrant pain
- Nausea and vomiting
- Generalized malaise
- Usually occurs in third-trimester, but one-third of cases occur postpartum

Source: ACOG Practice Bulletin et al., 2020

HELLP Syndrome

Monitoring

- Abdominal ultrasound to rule out liver rupture or hepatic bleeding
- Monitor LFTs and platelets every 12 hours

Management

- Delivery regardless of gestational age
- Transfer to tertiary care facility
- Supportive care
  - Treatment for preeclampsia
  - Blood transfusions if actively bleeding
- +/- corticosteroids

Source: ACOG Practice Bulletin et al., 2020

Assessment Question #1

Which of the following medications is considered first line for the management of preeclampsia with severe features?

A. Norepinephrine
B. Phenytoin
C. Magnesium sulfate
D. Levetiracetam

Assessment Question #1: Correct Response

Which of the following medications is considered first line for the management of preeclampsia with severe features?

A. Norepinephrine
B. Phenytoin
C. Magnesium sulfate
D. Levetiracetam

Patient Case #2

Patient Case #2

H&P

29 year-old F at 40 weeks of gestation presents to OBER with a planned induction. The following day, fetal deceleration was noted, patient became hypotensive and nonresponsive and sent to OR for emergency CS. The infant was delivered, but shortly after the patient lost a pulse.

Patient Case

To OR for emergent CS; infant delivered

Uterine atony leading to **postpartum hemorrhage** with EBL of 1700 mL

Managed with uterine massage, oxytocin, TXA, methylergonovine, carboprost, and misoprostol

Patient became hypotensive and lost pulse; ACLS begins for **cardiac arrest**

ECHO revealed significant RV dysfunction concerning for **amniotic fluid embolism**

Ongoing hemorrhage concerning for **disseminated intravascular coagulation** despite medications, MTP, balloon tamponade; hysterectomy performed

Cannulated for **VA ECMO** and transferred to ICU

Bleeding subsided, RV function returned to baseline, decannulated, and discharged home 13 days later

Postpartum Hemorrhage

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Post-Partum Hemorrhage (PPH)

ACOG definition

- At least 1,000mL total blood loss or blood loss coinciding with symptoms of hypovolemia within 24 hours of delivery

Epidemiology

- Occurs in 3% - 5% of deliveries in obstetric patients; leading cause of maternal morbidity worldwide

Risk Factors

- Maternal obesity
- Multiple gestations
- Preeclampsia
- Prolonged or augmented labor
- Retained placenta
- Can occur without risk factors up to 20%

Causes

- Tone
- Trauma
- Tissue
- Thrombin

Source: Baltaji et al., 2023; Evensen et al., 2017

PPH Management

Diagnosis

- Quantitative measurement of bleeding
- Tachycardia, orthostasis, hypotension, nausea, dyspnea, chest pain

Nonpharmacologic Management

- Manual placenta removal (if applicable)
- Airway, breathing and circulation assessment
- Massive transfusion protocol
- Uterus-conserving treatments (gauze soaked with vasopressin or carboprost (Hemabate))
- Balloon tamponade
- Hysterectomy

Source: Baltaji et al., 2023; Evensen et al., 2017

PPH caused by Uterine Atony

- Most common cause of PPH
- Uterus fails to contract during the third stage of labor
- Retained placenta, failure to expel placenta within 30 minutes, halts uterine contraction

Management

- Bimanual compression of the uterus
- Uterotonic medications
  - Oxytocin
  - Ergometrine
  - Misoprostol
  - Carboprost

Source: Baltaji et al., 2023; Evensen et al., 2017

Pharmacologic Management of PPH

Medication	Dose	Mechanism	Side Effects
Oxytocin	5 – 10 IU IV bolus or 20 – 40 IU in 1L Normal Saline infusion	Induces uterine contraction and decreases uterine blood flow	Hypotension
Carboprost	25 mcg IM or myometrium every 15 – 90 min for 2 mg total	Prostaglandin analogue, increases oxytocin receptors	Gastrointestinal upset
Methylergonovine	0.2 mg IM every 2 – 4 hours, followed by PO for 24 – 48 hours	Increases uterine contraction, vasoconstriction	Gastrointestinal upset, hypertension
Misoprostol	600 – 800 mcg SL or PO	Increases contraction of smooth muscle	Gastrointestinal upset, rigors, fevers
Tranexamic Acid (TXA)	1 g IV over 10 min	Inhibits plasmin breakdown of fibrin	Thrombotic risk

Source: Baltaji et al., 2023; Evensen et al., 2017

Effect of Early TXA Administration in PPH

WOMAN Trial	
Design	Randomized, double-blind, placebo-controlled trial
Intervention	1 g TXA in 10 mL infused over 10 min vs placebo
Inclusion	Women ≥ 16 y/o and PPH* after vaginal birth or CS
Outcomes	Primary - Composite of death from all causes or hysterectomy within 42 days Secondary - Thromboembolic events, surgical interventions, complications
Population	20,060 women; TXA, n=10,051 and placebo, n=10,009 - 46% were between ages of 26 – 33 y/o - Majority (71%) had vaginal deliveries - Majority (64%) had uterine atony

*PPH: EBL ≥ 500 mL after vaginal birth or ≥ 1000 mL after CS or any blood loss associated with hemodynamic instability

Source: WOMAN Trial Collaborators, 2017

Effect of Early TXA Administration in PPH

<table>
<tr><th colspan="2">WOMAN Trial</th></tr>
<tr><td>Primary Results</td><td>No difference in death from all cause or hysterectomy (534 (5·3%) TXA group vs 546 (5·6%) placebo group, p=0·65)
<table>
<tr><th>Cause of Death</th><th>TXA</th><th>Placebo</th><th>p-value</th></tr>
<tr><td>Bleeding</td><td>155 (1.5%)</td><td>191 (1.9%)</td><td>0.045</td></tr>
<tr><td>PE</td><td>10 (0.1%)</td><td>11 (0.1%)</td><td>0.82</td></tr>
<tr><td>Organ failure</td><td>25 (0.3%)</td><td>18 (0.2%)</td><td>0.29</td></tr>
</table></td></tr>
<tr><td>Secondary Results</td><td>- ↓death due to bleeding in TXA group (89 (1·2%) vs placebo (127 (1·7%), p=0·008) when administered within 3 hours of birth
- ↓ laparotomy in TXA group (82 (0.8%) vs placebo group (127 (1.3%), p=0.002)
- No difference in thromboembolic events or complications</td></tr>
<tr><td>Critique</td><td>- Results consistent with the CRASH-2 trial – TXA reduces death due to bleeding when given within 3 hours of insult
- TXA should be considered prior to 3 hours of birth</td></tr>
</table>

Source: WOMAN Trial Collaborators, 2017

Amniotic Fluid Embolism

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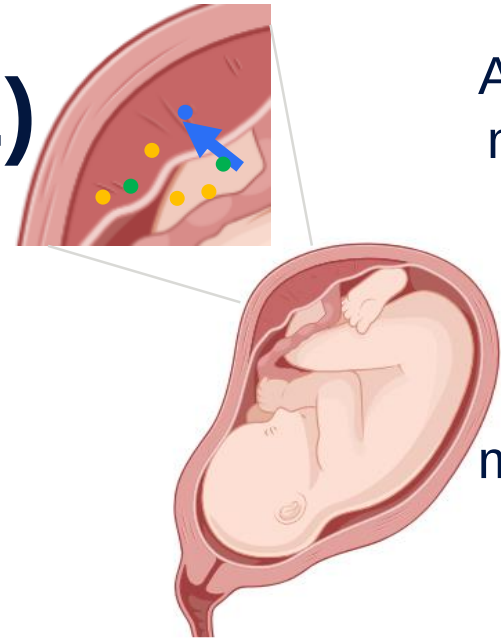
Amniotic Fluid Embolism (AFE)

Epidemiology

- 1 in 40,000 deliveries with a mortality of 20% - 60%

Diagnostic Criteria

- Presence of acute hypoxic respiratory failure, hypotension or cardiac arrest
- Presence of disseminated intravascular coagulopathy (DIC)
- Manifestation of symptoms during or within 30 minutes of delivery
- Exclusion of fever



Amniotic fluid enters maternal circulation

↓

Activation of proinflammatory mediators in response to fetal antigens

Systemic circulation

↓

Hypotension
Coagulopathies
Cerebral injury

Pulmonary circulation

↓

Hypoxia, pulmonary hypertension

↓

RV dysfunction

→ Cardiac arrest ←

Source: Baltaji et al., 2023; Clark et al.,2014

Amniotic Fluid Embolism

Risk Factors

- Operative delivery
- Cervical lacerations; uterine rupture
- Eclampsia
- Placenta complications (placenta previa, placenta accrete, placental abruption)

Management

Supportive Care

- Immediate-high quality CPR
- Venoarterial extracorporeal membrane oxygenation (VA ECMO)
- Atropine, ondansetron and ketorolac (A-OK protocol)

RV Failure

- Inotropes
  - Milrinone or dobutamine
- Vasopressors
- Pulmonary vasodilators
  - Inhaled prostacyclin
  - Inhaled nitric oxide
  - Sildenafil

DIC

- Blood products
- Uterotonics for atony
- Factor products
- TXA

Source: Clark et al., 2014; Pacheco et al., 2016

Disseminated Intravascular Coagulation in AFE

- Present in up to 83% of cases

Pathophysiology

- Hypercoagulable state characterized by microvascular thrombi and life-threatening bleeding due to the consumption of clotting factors and platelets
- Secondary to systemic inflammatory response releasing procoagulants into circulation

Management

- Massive transfusion protocol
- Utilization of thromboelastography (TEG) if available
- Antifibrinolytics if hyperfibrinolysis present
- Recombinant activated factor VII is controversial

Source: Clark et al., 2014; Pacheco et al., 2016

Use of Recombinant Factor VIIa (rVIIa) in AFE

Leighton et al., 2011	
Design	Systematic review of case reports from 2003 to 2009
Intervention	AFE patients receiving rVIIa vs no rVIIa
Inclusion	Meet the definition of AFE (once cardiac symptom + pulmonary symptom + DIC) and either received rVIIa OR did not receive rVIIa but had surgery
Outcome	Primary: Risk of negative outcome (permanent disability or death) Secondary: Full recovery, permanent disability, death
Population	16 rVIIa cases vs 28 non-rVIIa case - Average age 32 – 35 y/o - More patients received massive transfusion in rVIIa (93%) vs non-rVIIa (68%) - Higher median PRBC units transfused in the rVIIa (16) vs non-rVIIa (11.5)

Use of Recombinant Factor VIIa (rVIIa) in AFE

<table>
<tr><th colspan="2">Leighton et al., 2011</th></tr>
<tr><td>Primary Outcome</td><td>Negative outcome occurred in 14 (88%) of rVIIa group vs 11 (39%) of non-rVIIa cases (RR 2.2, 95% CI 1.4 – 3.7)</td></tr>
<tr><td>Secondary Outcome</td><td>
<table>
<tr><th>Characteristic</th><th>rVIIa case</th><th>Non-rVIIa case</th></tr>
<tr><td>Death</td><td>8 (50%)</td><td>7 (25%)</td></tr>
<tr><td>Permanent disability</td><td>6 of 8 (75%)</td><td>4 of 21 (19%)</td></tr>
<tr><td>Full recovery</td><td>2 (12.5%)</td><td>17 (60.7%)</td></tr>
<tr><td>Surgery</td><td>16 (100%)</td><td>28 (100%)</td></tr>
</table>
</td></tr>
<tr><td>Critique</td><td>- All case reports
- “Permanent disability” and “full recovery” were not defined
- Those who received rVIIa were likely sicker at baseline resulting in worse outcomes</td></tr>
</table>

Assessment Question #2

A 32 year old F at 39 weeks of gestation presents to OBER for a scheduled induction. Immediately following vaginal delivery, patient begins seizing and becomes hypoxic (O_2 saturation 79%) and hypotensive (BP 70/40 mmHg). Platelets noted to be 45 $x10^9$ /L and estimated blood loss is 1,050 L.

Which of the following obstetric emergencies might the above scenario describe?

A. Amniotic fluid embolism
B. Postpartum hemorrhage
C. Disseminated intravascular hemorrhage
D. All of the above

Assessment Question #2: Correct Response

A 32 year old F at 39 weeks of gestation presents to OBER for a scheduled induction. Immediately following vaginal delivery, patient begins seizing and becomes hypoxic (O_2 saturation 79%) and hypotensive (BP 70/40 mmHg). Platelets noted to be 45 $x10^9$ /L and estimated blood loss is 1,050 L.

Which of the following obstetric emergencies might the above scenario describe?

A. Amniotic fluid embolism
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C. Disseminated intravascular hemorrhage
D. **All of the above**

Cardiac Arrest in Pregnancy

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Cardiac Arrest in Pregnancy

Epidemiology

- 1 cardiac arrest per 12,000 admissions for delivery
- Rate of survival to hospital discharge up to 58.9% following maternal cardiac arrest

Physiologic changes in pregnancy

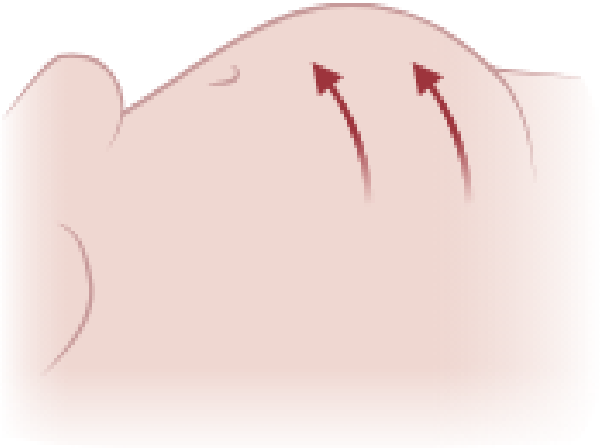
- Enlarging uterus → compresses aorta and decreases cardiac return
- Vasodilatory processes → systemic hypotension
- Increased ventilation → respiratory alkalosis with metabolic compensation
- Reduced residual lung capacity and increased oxygen consumption → worsens hypoxia
- Reduced gastric motility and relaxed gastroesophageal sphincters → risk of aspiration

Source: Jeejeebhoy et al., 2015

Basic Life Support in Pregnancy

Start CPR
Give oxygen/attach defibrillator

Manual left uterine displacement to relieve aortocaval compression



Early ventilatory support may be necessary due to lower oxygen reserves and higher metabolic demand

Check pulse

If VF/pVT
Shock

Defibrillate with shock energy of 120 to 200 J

Continue CPR

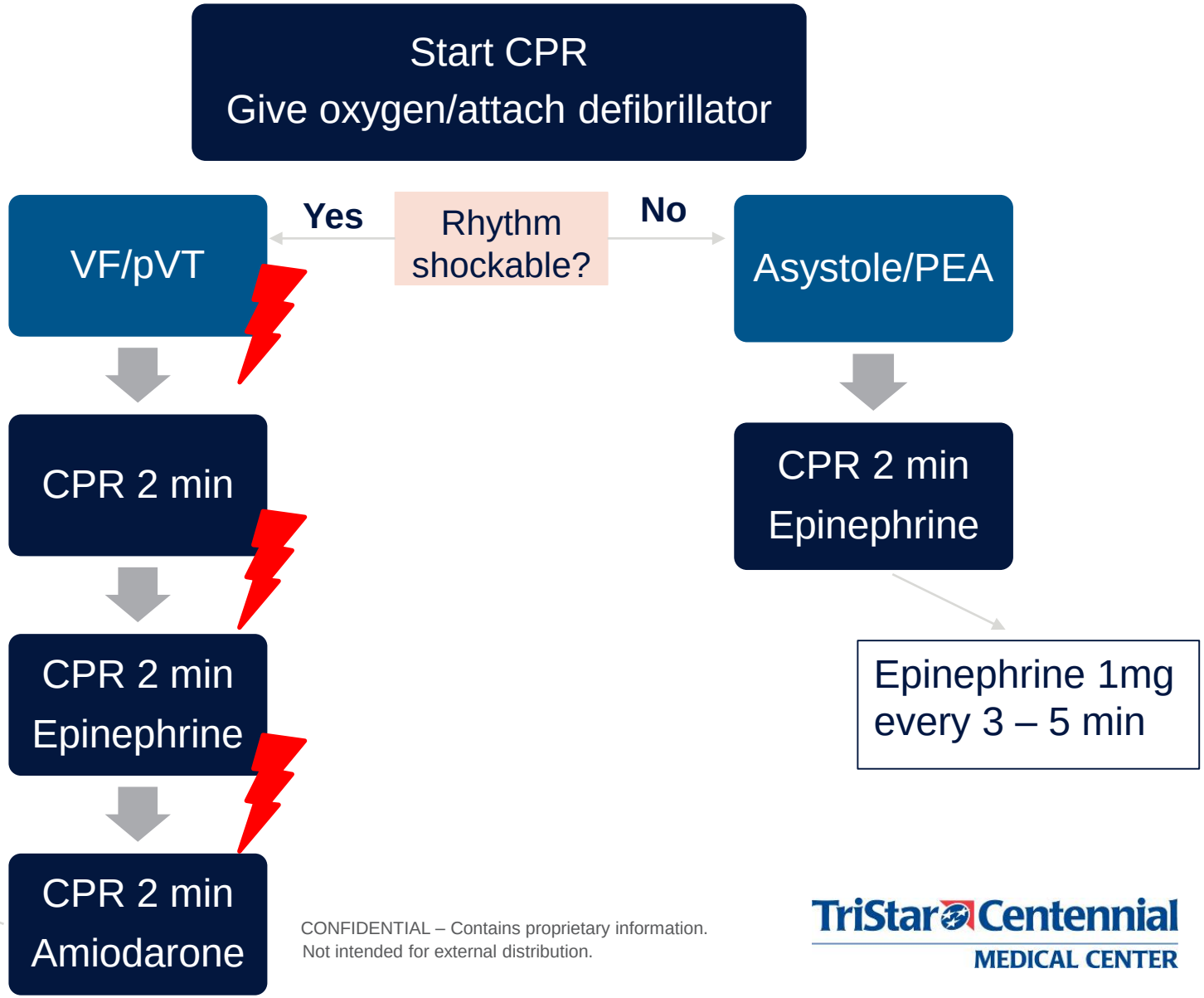
Continue CPR

Check CPR quality

Source: Jeejeebhoy et al., 2015

Advanced Cardiac Life Support (ACLS) in Pregnancy

- ACLS medications and doses do not differ from the non-pregnant patient
- Fetal concerns are overshadowed by the arrest outcome
- FDA categories of fetal risk of medications do not apply in cardiac arrest
- Perimortem cesarean delivery may be considered and is recommended after 4 minutes of CPR



Source: Jeejeebhoy et al., 2015

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Post resuscitation Care

General

- Place into left lateral decubitus position to decrease aortocaval compression
- Continuous fetal heart rate monitoring if infant undelivered

Fluids and Vasopressors

- Fluid administration should be individualized and Lactate Ringers is preferred
- Norepinephrine is first-line
- Vasopressin should be used with caution; vasopressin stimulates potent uterine contraction via activation of arginine vasopressin (AVP) receptors in the uterus

Analgesia and Sedation

- Opioids are first line, dexmedetomidine and propofol preferred over benzodiazepines

Source: Jeejeebhoy et al., 2015; Heavner et al., 2023

Post resuscitation Care

Drug/ Class	Crosses Placenta	Safe in pregnancy	Safe in lactation
Stress ulcer prophylaxis			
Famotidine	✓	✓	✓
Pantoprazole	✓	✓	✓
Anticoagulants			
Heparin	x	✓	✓
Warfarin	✓	x	✓
Direct Oral Anticoagulant	✓	x	x
Vasodilators			
Nitroglycerin	✓	?	?
Nitroprusside	✓	x	x
Antiarrhythmics			
Beta-blockers	✓	±	?
CCB	✓	✓	✓
Amiodarone	✓	x	?
Paralytics			
Nondepolarizing	✓	✓	✓
Depolarizing	x	✓	?

Source: Heavner et al., 2023

Assessment Question #3

True or False:

In the setting of a cardiac arrest, epinephrine doses should be adjusted to reduce fetal teratogenicity.

Assessment Question #3: Correct Response

True or False:

In the setting of a cardiac arrest, epinephrine doses should be adjusted to reduce fetal teratogenicity.

False

Extracorporeal Membrane Oxygenation in Pregnancy

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ECMO in Pregnancy

May be indicated in pregnant or postpartum patients with multi-organ dysfunction secondary to cardiac arrest or acute respiratory distress syndrome (ARDS)

<table>
<tr><th colspan="2">Bian et al., 2024</th></tr>
<tr><td>Design</td><td>Meta-analysis of 38 studies</td></tr>
<tr><td>Inclusion</td><td>Critically ill obstetric patients requiring ECMO support</td></tr>
<tr><td>Results</td><td>
<table>
<tr><td>Characteristic</td><td>Total, n=917</td></tr>
<tr><td>Indication for ECMO
AFE
Peripartum cardiomyopathy
ARDS
Cardiac arrest</td><td>
18 (4 studies)
65 (6 studies)
397 (23 studies)
31 (3 studies)</td></tr>
<tr><td>VV-ECMO
VA-ECMO</td><td>267
130</td></tr>
<tr><td>Survival</td><td>65% (95% CI 56 – 74%)</td></tr>
</table>
</td></tr>
</table>

Conclusion

Conclusion

- Obstetric emergencies in the ICU are rare, but it is imperative to understand how to manage them
- Many pharmacotherapy and physiologic considerations exist and must be considered in the treatment plan
- Magnesium sulfate is the drug of choice for preeclampsia and eclampsia
- Multiple emergencies exist in the immediate postpartum period including PPH, AFE and DIC
- Special consideration should be taken when pregnant or postpartum patients suffer cardiac arrest and require ECMO

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Thank You!

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