

OBSTETRIC EMERGENCIES SERIES

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THE SPOOKY SIDE OF

Preeclampsia







HELLP —— **Eclampsia**

MMRC = Maternal Mortality Review Committee

Among pregnancy-related deaths in 2022, MMRCs determined 94% to be preventable. ($^{768}/_{817}$)

HTN d/o of pregnancy was 6th leading cause of PRD, at **5.1%**[1]

Over 50% of maternal deaths from **PreE** have been considered preventable with earlier recognition, diagnosis, and treatment[2]

1. Maternal Mortality Prevention, CDC, 2025
2. Miller EC, Vollbracht S.. *Current Pain and Headache Reports.* 2021

Causes of Maternal M&M from HTN D/Os of Pregnancy:

- **ICH and cerebral infarction**
  - Among women with preE, autopsy and detailed case series suggest that neurological complications are the direct cause of 30–70% of deaths, most often ICH or cerebral edema
  - Often no underlying vascular lesion to account for the bleed[2]
- **Acute pulmonary edema**
- **Respiratory failure**
- **Hepatic failure or rupture**
- **Myocardial infarction**

Severe maternal complications include:

- Antepartum hemorrhage 2/2 placental abruption
- Eclampsia
- Cerebrovascular accidents
- Organ failure
- DIC

2. Miller EC, Vollbracht S. *Current Pain and Headache Reports.* 2021
3. Dennis AT. *Anaesthesia.* 2012

"Maternal Wellness Bias"

- Subconscious tendency to assume young, healthy-appearing pregnant women are well, even when S/Sx suggest otherwise.
  - Bias minimizes real medical conditions that can make pregnancy extremely high risk.
  - **Particularly worrisome in a progressively older & obese OB population**, where risks of severe maternal M&M are higher and compounded.
    - **Minimization of concerns voiced by the pt**, dismissal of abnormal VS & labs.
      - Eg: tachycardia often dismissed as "normal pregnancy", SOB attributed to "gravid uterus", postpartum fatigue accepted as "normal" rather than evaluated for possible sepsis or cardiomyopathy [4]

"Normalization of Deviance"

- Safety standards gradually erode over time after repeated encounters without negative outcomes
- Common in **OB** & Pedi, where abnormal outcomes are relatively infrequent and most pts *appear healthy*.
  - Eg: disregarding alarms, bypassing protocols, skipping checklists
    - Over time, unintentional denial, dismissal, & ultimately delays can lead to increased M&M
      - Unconscious biases toward marginalized populations widen disparities in Dx & Tx
      - These cognitive traps **delay *recognition & escalation of care***, placing maternal & fetal outcomes at risk [4]

Over 50% of maternal deaths from PreE have been considered preventable with earlier recognition, diagnosis, and treatment[2]

Table 1. Defining characteristics of preeclampsia and related disorders (ACOG 2019 revision)

Preeclampsia	
New-onset, persistent HTN at/after 20 wks in pt w previously normal BP **AND**	•SBP ≥ 140 mmHg or DBP ≥ 90 mmHg on two occasions at least 4 h apart, or •SBP of ≥ 160 mmHg or DBP ≥ 110 mmHg confirmed within a short interval (min)
Proteinuria	•≥ 300 per 24-h urine collection or •Protein/creatinine ratio of 0.3 mg/dL or more or •Urine dipstick reading of 2+ (if other quantitative methods unavailable)
OR In absence of proteinuria	•New onset of any of the following: •Thrombocytopenia •Renal insufficiency •Impaired liver function •Pulmonary edema •New-onset headache unresponsive to medication and not accounted for by alternative diagnoses, or visual symptoms
PreE variants & related D/Os:	
PreE superimposed on chronic HTN (SIPE)	•PreE in a woman diagnosed w/ chronic essential HTN •New-onset thrombocytopenia, elevated AST/ALT, sudden development of symptoms suggestive of PreE, or elevated uric acid levels suggest SIPE
HELLP syndrome (Hemolysis, Elevated Liver enzymes, Low Platelets)	**•LDH ≥ 600 IU/L** **•AST and ALT > twice the upper limit of normal** **•Platelet count < 100k**
Eclampsia	**•New-onset *tonic-clonic, focal, or multifocal* seizures in the absence of other causative conditions** (e.g., epilepsy, cerebral ischemia, ICH, drug use)

ACOG Criteria for Severe Features in PreE

(Meeting ONE criteria = **SF**. E.g. she does not have severe HTN, but PLT < 100k = she meets **SF** criteria)

- **Severe HTN:**
  - > 160 mm Hg or >110 mm Hg or higher
  - measured twice at least 4 hrs apart (unless anti-HTN tx initiated beforehand).
- **Thrombocytopenia:**
  - PLT < 100,000k
- **Impaired Liver Function:**
  - LFTs 2x upper limit of normal
  - *or* severe, persistent RUQ or epigastric pain unresponsive to medication (w/ no other dx)
- **Renal Insufficiency:**
  - Cr > 1.1 mg/dL or a doubling of Cr absent other kidney disease.
- **Pulmonary Edema**
- **New-Onset Neuro or Visual Symptoms:**
  - Severe HA unresponsive to acetaminophen (w/ no other cause)
  - *or* vision changes: blurry vision, flashing lights, or temporary loss of sight.

14. Espinoza et al. *ACOG PRACTICE BULLETIN No 222.* 2018

Classic Signs & Symptoms

- Headache
- Liver Dysfunction
- Renal Dysfunction
- Thrombocytopenia
- Eclamptic Seizures
- Hypertension
- Cardiopulmonary Complications



HEADACHES



Headaches in Preeclampsia

- **Severe HA or visual symptoms with HTN defines PreE**
  - 2/2 inflammation, BBB dysfunction, vascular endothelial dysfunction, and changes in vasoreactivity.
  - Can have HA without cerebral edema present
  - The HA of preE is often:
    - Progressive & bilateral
    - Pulsating in quality
    - Intractable to tx
    - Aggravated by physical activity.
    - Can have visual changes: blurry vision & scotomas (blind spots)
      - Can be mistaken for symptoms of migraine aura

2. Miller EC, Vollbracht S. *Current Pain and Headache Reports.* 2021

Headaches in Preeclampsia





Evaluation of HA in pregnant & postpartum women requires knowledge of which HA features should prompt:

- ✓escalation of care
- ✓involvement of a multidisciplinary neuro-obstetrics team.



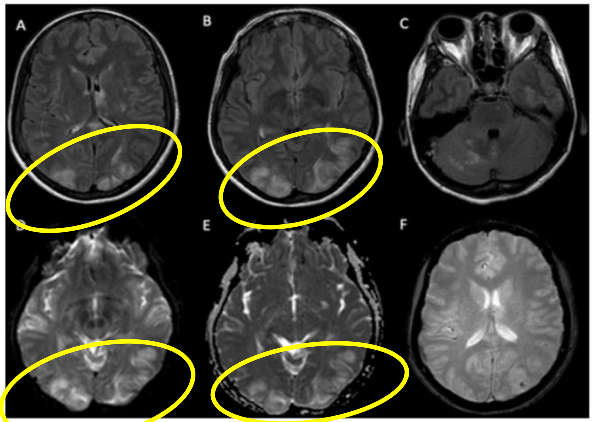
WHAT OTHER SPOOKY PATHOLOGY CAN HIDE BEHIND "A HEADACHE?"

2. Miller EC, Vollbracht S. *Current Pain and Headache Reports.* 2021

Headache DDX



- **PRES: Posterior Reversible Encephalopathy Syndrome**
  - Cerebral vasculature dysregulation & endothelial dysfunction causing vasogenic edema
  - **Occurs in up to ~90% of pts with eclampsia (literature range 10-90%)**
  - HA (~50%): insidious onset, dull quality, and b/l **occipital location**
  - Visual changes (~39%): ↓ acuity, diplopia, field deficits, cortical blindness, color vision changes & hallucinations.
  - Focal neurological deficits (~19%): aphasia & hemiparesis
  - AMS: Encephalopathy (~28%–94%): mild confusion to cognitive deficits to stupor & possible coma
  - Seizures (74%–87%), typically occur in first 24–48 hrs[5]
    - DX: **MRI** has superior resolution, esp of posterior fossa structures (CT ~50—60% show edema[6]
    - Posterior cortical & subcortical vasogenic edema
      - ICH found on imaging in 10%–25% pts
    - TX: Supportive measures, ICU care, controlled BP reduction
      - Nicardipine (5–15 mg/hr), Labetalol (2–3 mg/min) and PO Nimodipine
      - 2nd line agents: Sodium Nitroprusside, Hydralazine and Diazoxide.[5]

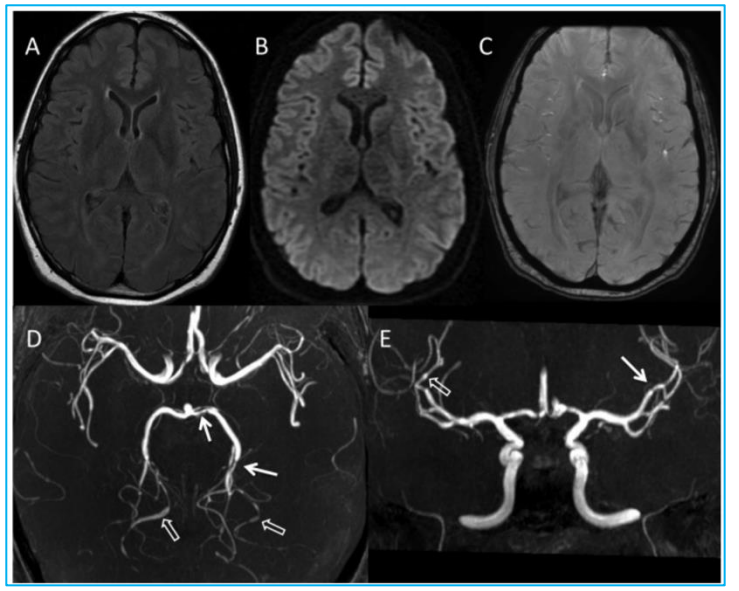


5. Triplett JD, Kutlubaev MA, Kermode AG, et al. *Practical Neurology*. 2022
6. Merlino et al. *Journal of Clinical Medicine*. 2023

Headache DDX



- **RCVS : Reversible Cerebral Vasoconstriction Syndrome**



https://www.sciencedirect.com/science/article/pii/S221156841830175X

  - Rare, usually 1–6 wks PP s/p uncomplicated pregnancy.
  - likely caused by female reproductive hormones
  - S/S:
    - **"Thunderclap"** HA (sudden onset, explosive pain with peak intensity in ~60sec)
      - multifocal arterial vasoconstriction and dilation.
    - N/V, photophobia, visual changes, confusion, phonophobia
    - Generalized tonic–clonic seizures and focal deficits have been reported.
  - DX: **MRA*** (CT scan may appear normal)
  - TX: CCB: Nimodipine PO, or Verapamil IV to relax cerebral vasculature.

6. Merlino et al. *Journal of Clinical Medicine*. 2023

Headache DDX

Cerebral Venous Sinus Thrombosis



- Up to half of pregnancy-related strokes
  - Majority occur PP
  - Higher risk in PreE :
    - ↑ endothelial activation, ↑PLT aggregability, ↑ blood viscosity, impaired cerebral autoregulation
  - Can be c/b low CSF pressure s/p wet tap or dehydration
- **Mortality rate ~12%**
- S/S:
  - typically diffuse, continuous & increasing HA
    - 10% severe stabbing HA
  - dizziness, nausea, seizures, papilledema, +/- laterality, lethargy & coma
  - NOT positional, not relieved, or only temporarily relieved by EBP
- DX: **MRI**, MR Venography, or CT Venography
  - Non-contrast CT often NEGATIVE
  - TX: Heparin or LMWH

https://radiologyinthai.blogspot.com/2011/06/cerebral-venous-sinus-thrombosis-cvst.html

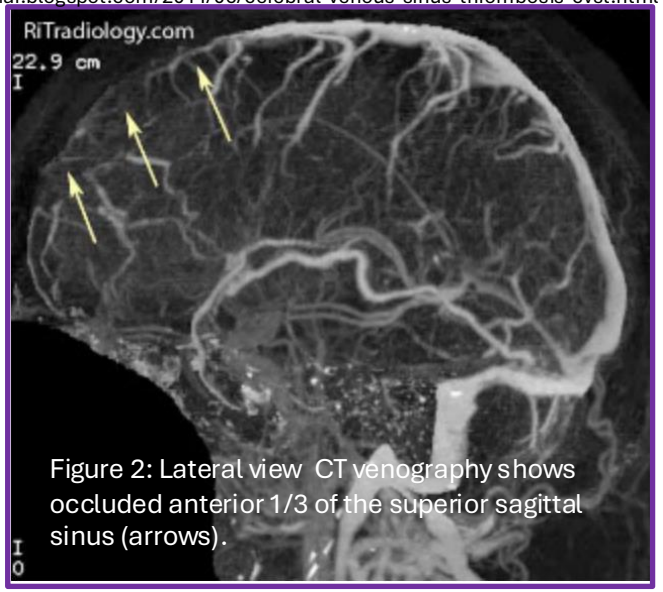


Figure 2: Lateral view CT venography shows occluded anterior 1/3 of the superior sagittal sinus (arrows).



6. Merlino et al. *Journal of Clinical Medicine.* 2023

Headache DDX








Other causes:

- Migraine
- Tension HA
- Cervical artery dissection (often assc w/ preE)
- Ischemic stroke (particularly posterior circulation)
- ICH or SAH
- PDPH
- Meningitis

SCAN ME

Table 2. SCAN ME: When to call neurology in a pregnant/PP pt with HA

S:	Sudden/severe/seizure
C:	Change in position (worse supine) or usual HA quality
A:	Altered mental status
N:	Neurological deficits/Nausea & vomiting
M:	Medications without relief
E:	Elevated BP or temperature

2. Miller EC, Vollbracht S. *Current Pain and Headache Reports.* 2021

LIVER DYSFUNCTION



ELEVATED LFTs DDX - OBSTETRIC CAUSES:

HELLP and Hepatic Rupture

- **Hepatic rupture** suspected when PreE pt has:
  - Acute onset of **severe epigastric or RUQ pain,** often radiating to the back
    - + abdominal tenderness
    - occasionally w/ right shoulder tip pain
    - can have nausea & vomiting
  - Or peritoneal signs
    - + hemodynamic features of hypovolemic shock with marked anemia
- Diagnostic Imaging: U/S, CT scan, or MRI
- *Can occur Postpartum!*

Glisson's Capsule

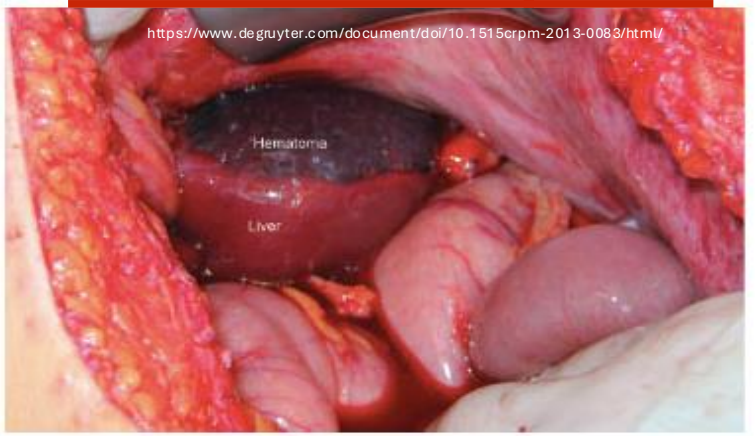


Figure 1



Fig.2: Intraoperative finding of subcapsular hematoma.

3. Dennis AT. *Anaesthesia.* 2012
7. Dennis AT, Xin A, Farber MK. *Anesthesiology.* 2025

ELEVATED LFTs DDX - OBSTETRIC CAUSES:

➢ Intrahepatic Cholestasis of Pregnancy

- Can have jaundice, but primary S/S: intense pruritus & elevated alk phos
  - but *NOT assc w/ abdominal pain, N/V, liver failure, or DIC*

➢ Acute Fatty Liver of Pregnancy (AFLP):

- Rare condition d/t impaired fetal fatty acid metabolism - **not assc w/ HTN**
  - most common in primips w/ male fetus
- **EMERGENCY: Stabilize mom → DELIVERY**
  - **VD if possible, but C/S d/t fetal compromise – 23% fetal mortality**
- **Maternal Mortality ~ 18%**
  - 2/2: sepsis, renal failure, circulatory collapse, pancreatitis or GI bleeding
  - **~50% chance of DIC** – PREPARE MTP, Aggressive CRYO
  - Among survivors, LFTs may ↑ for ~1 wk PP then slowly recover

S/S:

- **CNS signs: COMMON**: Encephalopathy, "acting strange," restless, seizures, psychosis, disorientation
- **Jaundice & Fever – COMMON**
- Metabolic acidosis from impaired clearance of lactate from damaged hepatocytes
- Hypoglycemia
- Excessive thirst
- Can occur with **pancreatitis, GI bleeding, & coagulopathy**
- ***HELLP overlap***
  - *Hemolysis & Thrombocytopenia*
  - *RUQ Pain*[8]

Swansea Criteria for AFLP[9]

Six of the features below are required for the diagnosis	
Clinical features	■ Nausea and vomiting ■ Abdominal pain ■ Encephalopathy ■ Polyuria or polydipsia
Laboratory features	■ Bilirubin >0.8 mg/dL ■ Hypoglycemia <72 mg/dL ■ WBC >11x10^9/L ■ AST or ALT >42 units/L ■ AKI or Cr >1.7 mg/dL ■ Coagulopathy or PT >14 sec ■ Ammonia >47 μmol/L ■ Urate >340 μmol/L
Ultrasonographic features	Ascites or echogenic liver
Histologic features	Microvesicular steatosis on liver biopsy

8. Ko HH, Yoshida E. *Canadian Journal of Gastroenterology.* 2006
9. Nelson D, Schell R. Acute Fatty Liver of Pregnancy. *wwwcontemporaryobgynnet.* 2021

ELEVATED LFTs DDX - Non-Obstetric Causes:

- Viral hepatitis
- Drug toxicity
- NAFLD
- Chronic autoimmune dx (eg: lupus)

RENAL DYSFUNCTION



Renal Dysfunction



- Cr 0.6 is normal ceiling in healthy pregnancies.
  - 2/2 increases in GFR beginning in 1st TM.
- > 0.6 after ~9-12 wks is abnormal, > 1.0 needs workup

- PreE pts may *not be candidates for PP ketorolac/NSAIDS* if impaired renal function.
  - Abnormal Cr likely WON'T flag on labs, as hospitals rarely have different pregnancy thresholds implemented.[7]

Mag Toxicity is particularly likely with significant renal insufficiency

AKI

- ✓ *↑ serum Cr to 1.5x baseline*
- ✓ *or ↑ serum Cr of >/= 0.3 mg/dl or*
- ✓ *>/= ↑ 50% increase within 48 h*
- ✓ *UO < 0.5 ml/kg for > 6 h.*
- ✓ ***AKI predisposes PreE pts to acute pulmonary edema*** [7]

Hemolytic Uremic Syndrome (HUS)

- **Complement-mediated significant endothelial damage, esp to renal microvasculature**
  - **AKI/renal failure ***
- + Thrombocytopenia: microangiopathic hemolytic anemia
- Possible fever
- Early PP – RFP worsening, NOT improving (as expected PP in HELLP)[10,11]

7. Dennis AT, Xin A, Farber MK. *Anesthesiology.* 2025
10. Scully M, Neave L. *Research and Practice in Thrombosis and Haemostasis.* 2023
11. Neave L, Scully M. *Transfusion Medicine in Obstetrics.* 2018

THROMBOCYTOPENIA



THROMBOCYTOPENIA- DDX

12. Bauer ME, Arendt K, Beilin Y, et al. *Anesthesia & Analgesia*. 2021

Table 1. Common Etiologies of Thrombocytopenia During Pregnancy and Postpartum

Disease	Incidence during pregnancy (%)	Diagnostic features	Laboratory findings	Clinical symptoms and physical examination	Pathophysiology
Gestational thrombocytopenia	5–11	Common onset during late second or third trimester, normal platelet count outside of pregnancy	Platelet count >75,000 × 10^6/L	Typically normal	Unclear
ITP	<1	Onset at any trimester, thrombocytopenia outside of pregnancy possible	Platelet count <100,000 × 10^6/L ± large platelets on PBS	Rarely may have signs of bleeding, bruising, and petechiae	Antibody induced peripheral platelet destruction and decreased bone marrow production
Preeclampsia	5–8	Onset in late second or third trimester (>20 wk of gestation)	≥300 mg urine protein in 24 h or protein/creatinine ratio of ≥0.3 or end organ injury	Systolic BP ≥140 mm Hg or diastolic BP ≥90 mm Hg	Systemic endothelial dysfunction Inadequate placentation
HELLP syndrome	<1	70% onset in late second or third trimester, 30% onset postpartum	MAHA elevated LFTs elevated LDH	Any or all signs of preeclampsia may be present, in 15%–20% of cases no hypertension or proteinuria is present, platelet count nadir occurs 24–48 h after delivery	Systemic endothelial dysfunction Inadequate placentation

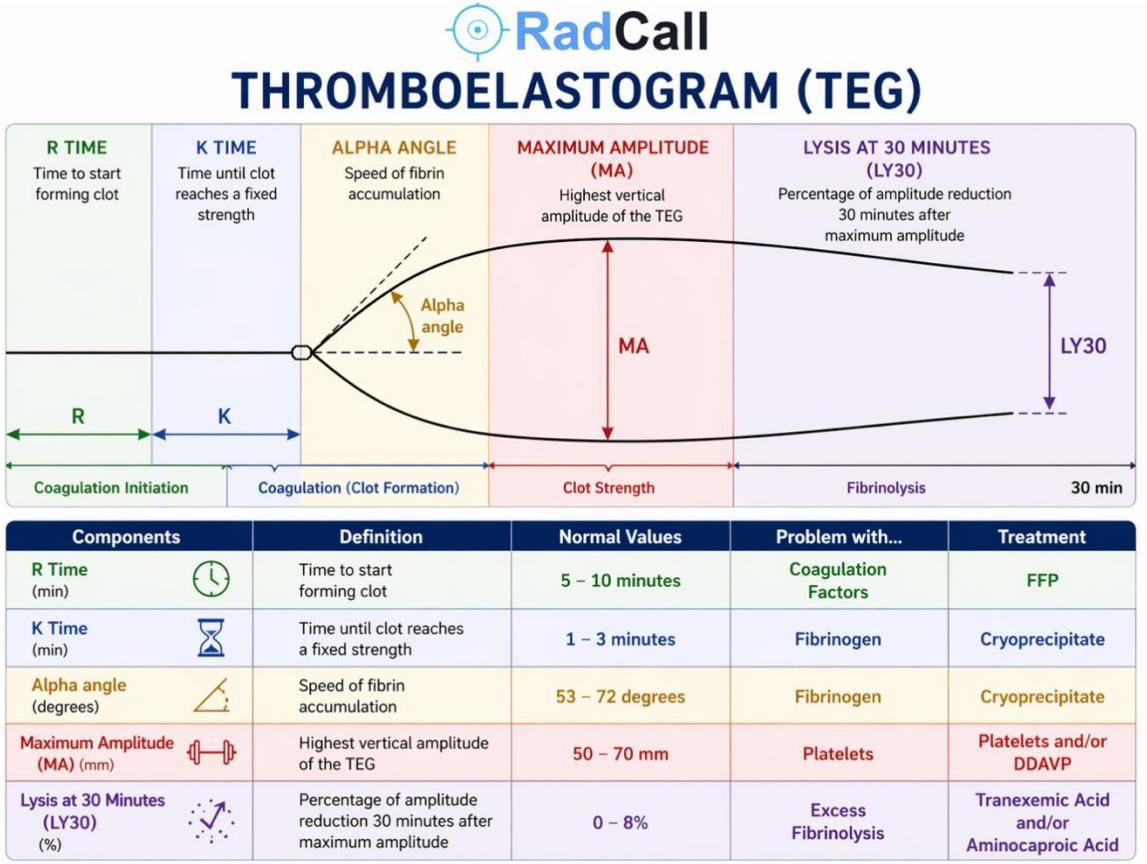
THROMBOCYTOPENIA- DDX

➢ Immune Thromobocytopenia Purpura

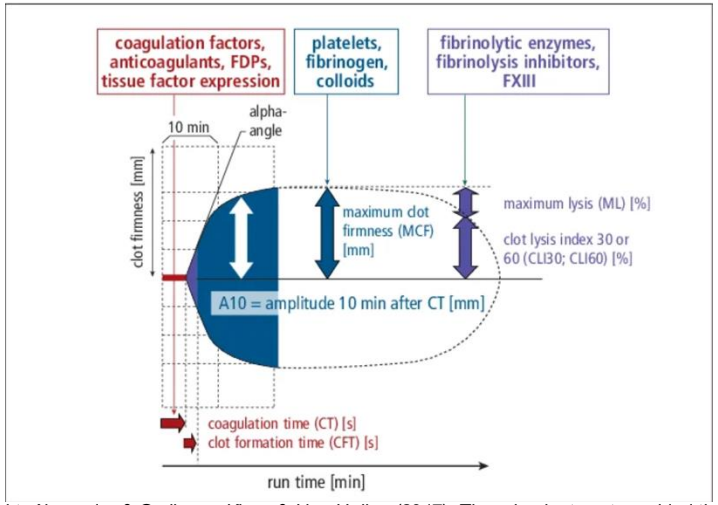
- The OG classic
- Immune response: autoantibodies to PLTs
- PLT quality usually fine despite lower quantity
- TEG or ROTEM if available prior to neuraxial if PLT 50-80k
- TX: Corticosteroids

➢ *Pseudo*thrombocytopenia

- False alarm
  - PLTs clump abnormally from EDTA (anticoagulant) added to sample.
- **"PLT Clumping"** seen on blood smear – usually noted by lab in comment.
- Re-draw PLT with different anticoagulant: *Na^+ Citrate or Heparin.*
- Can confirm PLT function with TEG or ROTEM.



Components	Definition	Normal Values	Problem with...	Treatment
R Time (min)	Time to start forming clot	5 – 10 minutes	Coagulation Factors	FFP
K Time (min)	Time until clot reaches a fixed strength	1 – 3 minutes	Fibrinogen	Cryoprecipitate
Alpha angle (degrees)	Speed of fibrin accumulation	53 – 72 degrees	Fibrinogen	Cryoprecipitate
Maximum Amplitude (MA) (mm)	Highest vertical amplitude of the TEG	50 – 70 mm	Platelets	Platelets and/or DDAVP
Lysis at 30 Minutes (LY30) (%)	Percentage of amplitude reduction 30 minutes after maximum amplitude	0 – 8%	Excess Fibrinolysis	Tranexemic Acid and/or Aminocaproic Acid



Vorweg, M. & Albrecht, Alexander & Görlinger, Klaus & Lier, Heiko. (2017). Thromboelastometry guided therapy of severe bleeding: Essener Runde algorithm. Hämostaseologie. 33. 51-61. 10.5482/HAMO-12-05-0011

THROMBOCYTOPENIA- DDX

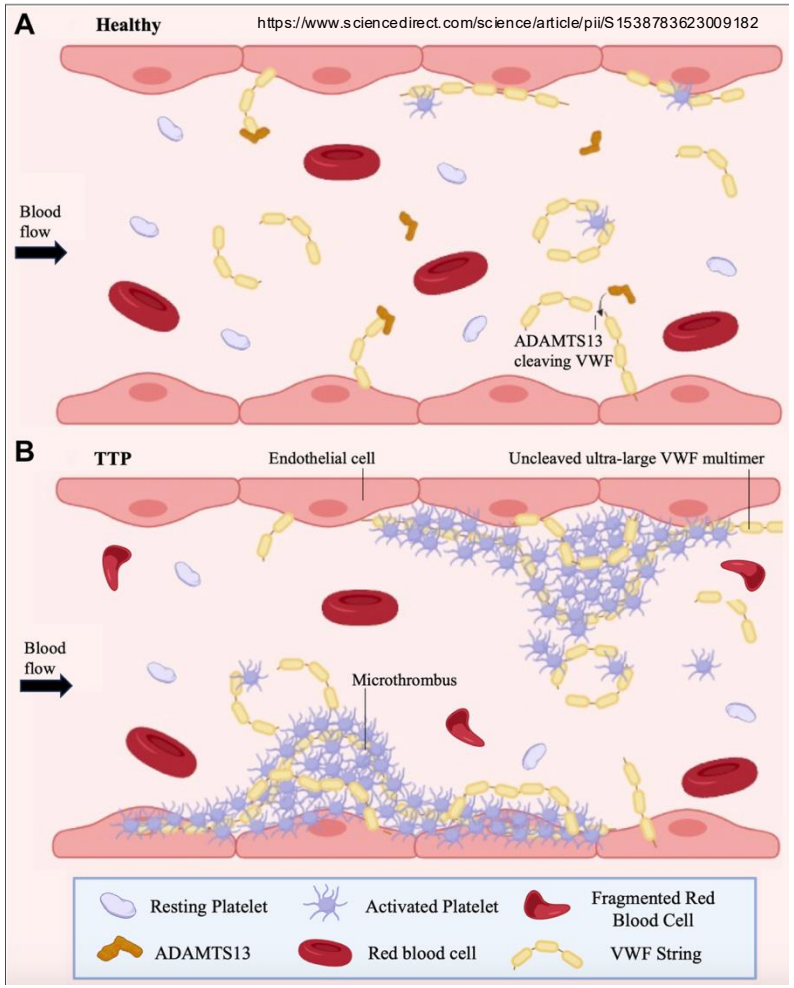
Rare Thrombotic Microangiopathies:

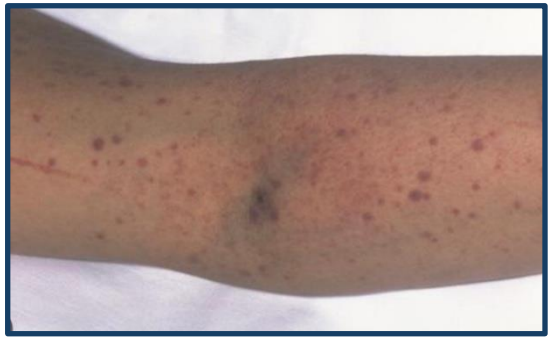
➢ Hemolytic Uremic Syndrome (HUS)

- **Complement-mediated significant endothelial damage, esp renal microvasculature**
  - **AKI/renal failure ***
- Thrombocytopenia: microangiopathic hemolytic anemia
- Possible fever
- Early postpartum – RFP continues to worsen, NOT improve (as expected PP in HELLP)
- TX: complement inhibitors (ie: eculizumab) + plasma therapy

➢ Thrombotic Thrombocytopenia Purpura (TTP)

- ADAMTS13 deficiency from autoantibodies or genetic mutation <10% normal values
  - ADAMTS13 cleaves vWF into a reasonable size. Without it, vWF grows out of control forming massive strings, trapping & consuming PLTs
- Micro thrombi in microvasculature → ischemia → renal, liver, neuro damage.
- **Neurological s/s: stroke, confusion***
- **Petechia and Purpura (bigger than petechia: 2-10mm spots)**
- Schistocytes
- **COMMON Fever**
- 2nd or 3rd TM
- TX: plasma exchange – need new plasma with functional ADAMS TS13.[10-11]







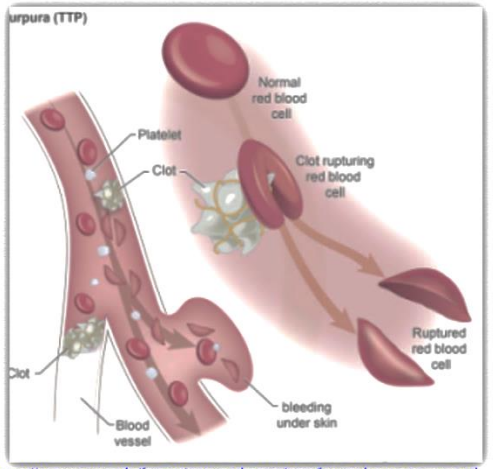
10. Scully M, Neave L. *Research and Practice in Thrombosis and Haemostasis.* 2023
11. Neave L, Scully M. *Transfusion Medicine in Obstetrics.* 2018

HELLP, TTP, HUS = Hemolytic anemias = microvasculature clots/inflammatory clots are physically damaging RBCs

LAB FINDINGS in HEMOLYSIS:

- **Schistocytes:**
  - **Indicates profound widespread microangiopathic thrombosis**
  - **Considered a hematologic emergency. (NO NEURAXIAL)**
    - (HELLP, hemolytic anemia, TTP, HUS)
- **Elevated Billirubin** 2/2 increased hemoglobin catabolism
  - **> 1.2mg**
- **Elevated Lactate dehydrogenase**. LDH released from RBC breakdown
  - (normal ~140-280 u/L, **hemolysis dx > 600 u/L**)
- **Elevated ALT/AST**
  - (normal ~8-50 u/L, **elevated > 70 IU/L)**
- **Thrombocytopenia**
  - **< 100K from consumption**
- **Decreased Serum haptoglobin.** SH binds free hemoglobin from lysed RBCs – rapidly consumed in hemolytic states.
  - (normal 40-200, **< 40 mg/dL**)

- As systemic inflammation of microvasculature activates PLTs—> activates coagulation cascade —> forms PLT plugs and tiny fibrin clots along the microvascular endothelium
- RBCs floating through these micro vessels get damaged/sheared from scraping along these hardened fibrin clots (**SCHISTOCYTES**)



https://cancer.osu.edu/for-patients-and-caregivers/learn-about-cancers-and-treatments/cancers-conditions-and-treatment/benign-blood-diseases/thrombotic-

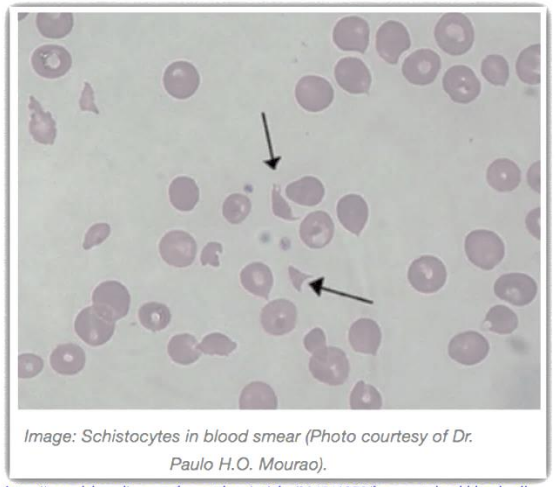


Image: Schistocytes in blood smear (Photo courtesy of Dr. Paulo H.O. Mourao).

https://www.labmedica.com/hematology/articles/294741378/fragmented-red-blood-cell-measurement-automated.html

SOAP Consensus Guidelines:
Neuraxial in OB Patients With Thrombocytopenia:

Obstetric Anesthesiology

SPECIAL ARTICLE

The Society for Obstetric Anesthesia and Perinatology Interdisciplinary Consensus Statement on Neuraxial Procedures in Obstetric Patients With Thrombocytopenia

RISK v BENEFIT

IF:

- ✓ NO bleeding assc w/ thrombocytopenia
- ✓ NO additional hematological comorbidity
- ✓ NO rapid rate of ↓ in PLTs
- ✓ YES normal coagulation (coags +/-TEG/ROTEM)
- ✓ YES PLT >/= 70k within past 6h

It may be reasonable to proceed with neuraxial analgesia.

** especially if significant airways concerns are present **

- No good evidence to guide this situation when combined w/ low-dose aspirin therapy*
- Neuraxial in low but ***stable**** PLTs likely **safer** than the same low but ***rapidly falling**** PLTs.[12, 13]

12. Bauer ME, Arendt K, Beilin Y, et al. *Anesthesia & Analgesia.* 2021
13. Harris M. *The ObG Project.* 2023

SOAP Consensus Guidelines: Neuraxial in OB Patients With Thrombocytopenia:

- Up to 12% of OB pts have thrombocytopenia
- ~ 1% have PLT < 100k
- Incidence of spinal/epidural hematoma in general OB population:
  - 1:200k to 1:250k



Approach to obstetric patients with thrombocytopenia

Platelet count <50,000 × 10^6/L
Risk of spinal epidural hematoma likely increased, reasonable to avoid neuraxial

Platelet count 50,000 – 70,000 × 10^6/L
Competing risks/benefits may justify proceeding with a neuraxial procedure

Platelet count ≥70,000 × 10^6/L
Risk of spinal epidural hematoma likely low, reasonable to proceed with neuraxial

Upper limit of 95% CI for hematoma risk by PLT count:

- **< 50k = 9%**
- **50-69k = 2.6%**
- **70-100k= 0.19%**

Exceptions to above 👆:

1. Assessment of hemostasis via detailed bleeding hx crucial to risk-benefit decisions. If significant bleeding hx or current concern for coagulapathy, reasonable to avoid neuraxial and consult heme regardless of PLT count
2. In pts w/ HELLP, consider repeating PLT if >6 hrs since last result
3. For cases with unknown etiology of thrombocytopenia w/ PLT count < 70k, + heme workup before neuraxial beneficial
4. In setting of assc coagulopathy (ex. hemophilia), elevated PT/PTT, or anticoagulation, consider heme consult regardless of PLT count

12. Bauer ME, Arendt K, Beilin Y, et al. *Anesthesia & Analgesia.* 2021

ECLAMPTIC SEIZURES



ACOG Criteria for Severe Features in PreE

(Meeting ONE criteria = **SF**. E.g. she does not have severe HTN, but PLT < 100k = she meets **SF** criteria)

- **Severe HTN:**
  - > 160 mm Hg or >110 mm Hg or higher
  - measured twice at least 4 hrs apart (unless anti-HTN tx initiated beforehand).
- **Thrombocytopenia:**
  - PLT < 100,000k
- **Impaired Liver Function:**
  - LFTs 2x upper limit of normal
  - *or* severe, persistent RUQ or epigastric pain unresponsive to medication (w/ no other dx)
- **Renal Insufficiency:**
  - Cr > 1.1 mg/dL or a doubling of Cr absent other kidney disease.
- **Pulmonary Edema**
- **New-Onset Neuro or Visual Symptoms:**
  - Severe HA unresponsive to acetaminophen (w/ no other cause)
  - *or* vision changes: blurry vision, flashing lights, or temporary loss of sight.

14. Espinoza et al. *ACOG PRACTICE BULLETIN No 222.* 2018

Hypertensive Emergency Checklist

Hypertensive Emergency:

- Two severe BP values (≥160/110) taken 15-60 minutes apart. Values do not need to be consecutive.
- May treat within 15 minutes if clinically indicated

- ☐ Call for Assistance
- ☐ Designate:
  - ○ Team leader
  - ○ Checklist reader/recorder
  - ○ Primary RN
- ☐ Ensure side rails up
- ☐ Ensure medications appropriate given patient history
- ☐ Administer seizure prophylaxis (magnesium sulfate first line agent, unless contraindicated)
- ☐ Antihypertensive therapy within 1 hour for persistent severe range BP
- ☐ Place IV; Draw preeclampsia labs
- ☐ Antenatal corticosteroids (if <34 weeks of gestation)
- ☐ Re-address VTE prophylaxis requirement
- ☐ Place indwelling urinary catheter
- ☐ Brain imaging if unremitting headache or neurological symptoms
- ☐ Debrief patient, family, and obstetric team

† "Active asthma" is defined as:
Ⓐ symptoms at least once a week, or
Ⓑ use of an inhaler, corticosteroids for asthma during the pregnancy, or
Ⓒ any history of intubation or hospitalization for asthma.

Magnesium Sulfate

Contraindications: Myasthenia gravis; avoid with pulmonary edema, use caution with renal failure

IV access:

- ☐ Load 4-6 grams 10% magnesium sulfate in 100 mL solution over 20 min
- ☐ Label magnesium sulfate; Connect to labeled infusion pump
- ☐ Magnesium sulfate maintenance 1-2 grams/hour

No IV access:

- ☐ 10 grams of 50% solution IM (5 g in each buttock)

Antihypertensive Medications

For SBP ≥ 160 or DBP ≥ 110
(See SMI algorithms for complete management when necessary to move to another agent after 2 doses.)

- ☐ **Labetalol** (initial dose: 20mg); **Avoid parenteral labetalol with active asthma, heart disease, or congestive heart failure; use with caution with history of asthma**
- ☐ **Hydralazine** (5-10 mg IV* over 2 min); **May increase risk of maternal hypotension**
- ☐ **Oral Nifedipine** (10 mg capsules); Capsules should be administered orally, not punctured or otherwise administered sublingually

** Maximum cumulative IV-administered doses should not exceed 220 mg labetalol or 25 mg hydralazine in 24 hours*

***Note:** If first line agents unsuccessful, emergency consult with specialist (MFM, internal medicine, OB anesthesiology, critical care) is recommended*

Anticonvulsant Medications

For recurrent seizures or when magnesium sulfate contraindicated

- ☐ **Lorazepam (Ativan)**: 2-4 mg IV x 1, may repeat once after 10-15 min
- ☐ **Diazepam (Valium)**: 5-10 mg IV q 5-10 min to maximum dose 30 mg

Safe Motherhood Initiative

ACOG The American College of Obstetricians and Gynecologists District II

Revised January 2019

ACOG published checklists for: **Hypertension,** as well as specific algorithms for **IV Labetalol,** IV Hydralazine, & PO IR Nifedipine

Labetalol Algorithm

EXAMPLE

Trigger: If severe elevations (SBP ≥160 or DBP ≥ 110) persist* for 15 min or more **OR** If two severe elevations are obtained within 15 min and tx is clinically indicated

1. **Labetalol 20 mg† IV over 2 minutes**
2. **Repeat BP in 10 minutes**
3. **If SBP ≥ 160 or DBP ≥ 110, administer labetalol 40 mg IV over 2 minutes; If BP below threshold, continue to monitor BP closely**
4. **Repeat BP in 10 minutes**
5. **If SBP ≥ 160 or DBP ≥ 110, administer labetalol 80 mg IV over 2 minutes; If BP below threshold, continue to monitor BP closely**
6. **Repeat BP in 10 minutes**
7. **If SBP ≥ 160 or DBP ≥ 110, administer hydralazine§ 10 mg IV over 2 minutes; If below threshold, continue to monitor BP closely**
8. **Repeat BP in 20 minutes**
9. **If SBP ≥ 160 or DBP ≥ 110 at 20 minutes, obtain emergency consultation from specialist in MFM, internal medicine, anesthesiology, or critical care**
10. **Give additional antihypertensive medication per specific order as recommended by specialist**
11. **Once BP thresholds are achieved, repeat BP:**
12. **- Every 10 minutes for 1 hour**
    - Then every 15 minutes for 1 hour
    - Then every 30 minutes for 1 hour
    - Then every hour for 4 hours
13. **Institute additional BP monitoring per specific order**

- Notify provider after one severe BP value is obtained
- Institute fetal surveillance if viable
- Hold IV labetalol for maternal pulse under 60
- Maximum cumulative IV-administered dose of labetalol should not exceed 300 mg in 24 hours
- There may be adverse effects and contraindications. Clinical judgement should prevail.

* Two severe readings more than 15 minutes and less than 60 minutes apart

† **Avoid parenteral labetalol with active‡ asthma, heart disease, or congestive heart failure; use with caution with history of asthma. May cause neonatal bradycardia.**

‡ "Active asthma" is defined as:
Ⓐ symptoms at least once a week, or
Ⓑ use of an inhaler, corticosteroids for asthma during the pregnancy, or
Ⓒ any history of intubation or hospitalization for asthma.

§ Hydralazine may increase risk of maternal hypotension.

Safe Motherhood Initiative

ACOG The American College of Obstetricians and Gynecologists District II

Revised February 2020

Recent legal case: maternal stroke s/p eclamptic seizure

07:53 Pt admitted 37w 4d pCS twins. On admission, pt c/o difficulty breathing, PLT 98 from 3d prior
08:15, 09:15, 09:29 Rpt PLT 84k, anes pre-op completed, then UA + proteinuria
10:04 C/S prep, pre-neuraxial BP 170/76
10:20: 200mcg neo for nausea s/p neuraxial and BP drop. 170 → 140-150 systolic
10:22, 10:31, 10:32 c/s start, delivery baby #1, delivery baby #2
10:30-11:00 BP drops from 170s to 150s systolic and pt c/o N/V, HA
10:30-11:15 40-50mg Ephedrine administered
11-11:15 30mg ketorolac charted (Anes edited: "OK per OB but I decided not to give it b/c PLT low")
11:20 3mg midazolam given + labetalol 20mg for "panic attack" *(it was actually a seizure)*
11:25 C/S end, **11:36** Anesthesia end
11:38 PACU entry **BP 152/76,** Both OB & Anes documented "intra-op Severe BP & HA developed"
11:40 $MgSO_4$- started
13:13 BP 162/85
13:28 BP 169/87
14:29 RRT pt LOC, agonal breathing → stat head CT scan
14:55 Mag level 4.5 (units?) → deemed toxic → Calcium gluconate 1g IV
15:00 Anes called for airway management
15:15 Head CT confirmed massive ICH, non-survivable, brain dead
20:45 Confirmed brain death exam, pronounced dead on May 9, 2017

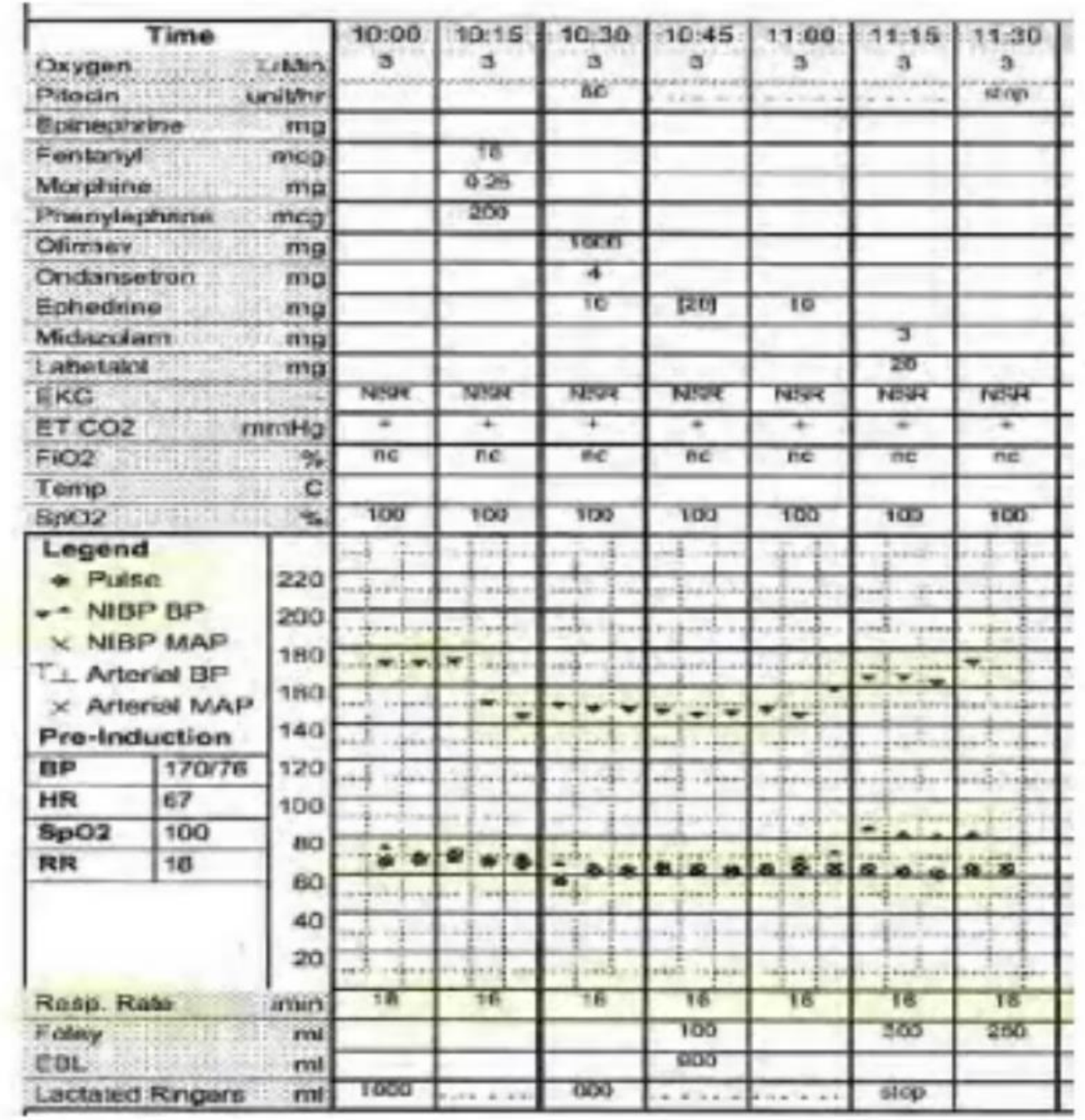
Pt's brain sent to Mayo for further autopsy – found no underlying vascular anomalies*

15. Brain Bleed During C-Section. *Anesthesiology Malpractice*. August 6, 2026.

Witness Anesthesiologist for the Plantiff:

- **Anes fell below standard of care:**

- Failed to appreciate severity of pt condition
- Q5 min BP inadequate monitoring
- Continued to give ephedrine (contraindicated in severe range BP) *post-delivery*, which was unwarranted
- Ketorolac inappropriate, if actually administered as charted.
- Failed to recognize post-delivery seizure and mistook for “panic attack.”
- Failed to call neuro consult/ scan earlier



Time		10:00	10:15	10:30	10:45	11:00	11:15	11:30
Oxygen	L/min	3	3	3	3	3	3	3
Pitocin	unit/hr			80				stop
Epinephrine	mg							
Fentanyl	mcg		10					
Morphine	mg		0.25					
Phenylephrine	mcg		200					
Olimev	mg			1000				
Ondansetron	mg			4				
Ephedrine	mg			10	[20]	10		
Midazolam	mg						3	
Labetalol	mg						20	
EKG		NSR	NSR	NSR	NSR	NSR	NSR	NSR
ET CO2	mmHg	+	+	+	+	+	+	+
FiO2	%	nc	nc	nc	nc	nc	nc	nc
Temp	C							
SpO2	%	100	100	100	100	100	100	100
Resp. Rate	/min	18	18	18	18	18	18	18
Foley	ml				100		300	250
EBL	ml				900			
Lactated Ringers	ml	1000		900			stop	

Legend: Pulse; NIBP BP; NIBP MAP; Arterial BP; Arterial MAP

Pre-Induction: BP 170/76; HR 67; SpO2 100; RR 18

220 200 180 160 140 120 100 80 60 40 20

15. Brain Bleed During C-Section. *Anesthesiology Malpractice*. August 6, 2026.

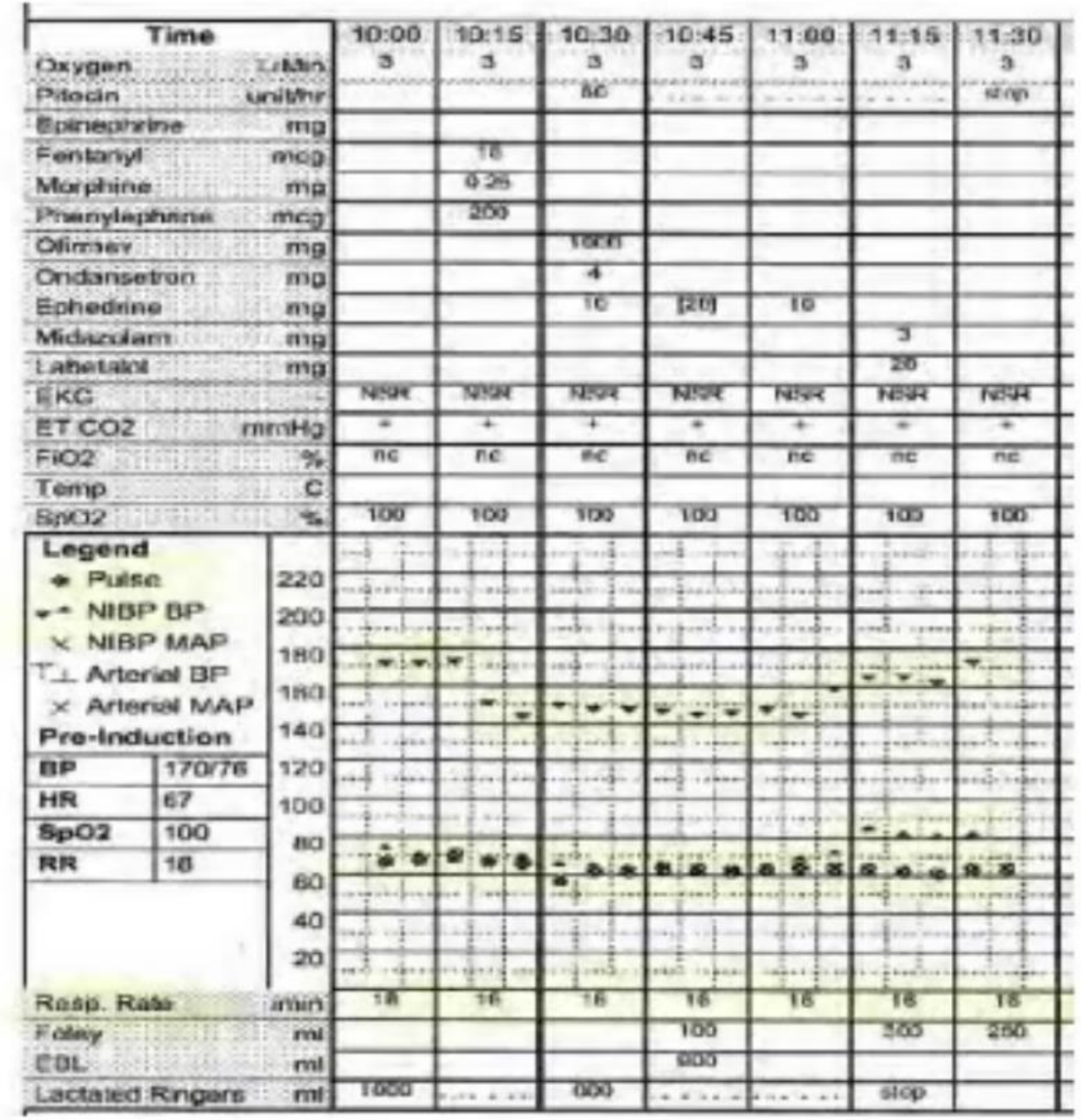
Witness Anesthesiologist for the Defense:

- **Anes followed standard of care**

- Neither Pre-op **SF PreE** *nor* **PLT** would have changed appropriate anesthesia plan for neuraxial.
- Anes aware of BP but planned to see how much spinal would lower BP before tx
- Ephedrine appropriate if used to maintain BP and ***did not*** cause Brain bleed (occurred hours later)
- Addendum to edit Toradol admin is OK and med wasn't given

Jury awared: $22 million payout.

- OB 65% liable (but settled)
- Anesthesiologist 35% liable ($8 million)



15. Brain Bleed During C-Section. *Anesthesiology Malpractice*. August 6, 2026.

MedMal Reviewer/Anesthesiologist Analysis 🔎

- Overall, seems like incredibly sad tragedy that was completely paradoxical.
- I don't think any reasonable anesthesiologist or OB is going to rush someone to CT scan scan immediately after a C/S unless neuro deficits or unresponsive
- Earlier DX may not have led to a better outcome.
- Whether you believe ephedrine or Toradol played a role in this bleed or not, *there is no denying the optics of the situation*. Certain actions or meds are going to look bad when there is a poor outcome and open us up to criticism and therefore liability.
- While defensive medicine shouldn't control your practice, it is beneficial to reflect on these situations.[15]

IMO Analysis 🔎

- Per ACOG –pt had SF PreE pre-op: proteinuria, thrombocytopenia < 100K – BP?
- $MgSO_4$- should have been loaded & running before and through c/s per ACOG – clear SF BP prior to neuraxial.
- YES do everything to avoid nausea and *vomiting** in HTN pt with low PLTs, but treat post-delivery nausea w/ additional **anti-emetics,** or at LEAST chart & give those **FIRST** before last-line pressors. Only 4mg Zofran charted at start. BP does not need to stay elevated after delivery - no fetal perfusion thresholds .
- Spinal OK, Toradol correct not to give in thrombocytopenia w/ falling PLTs – was Cr even checked?
- Labetalol 20mg is only the 1st step of severe HTN management. ACOG algorithm doubles dose Q10 min 20mg →40mg →80mg if severe HTN sustained. No subsequent doses were given for sustained severe HTN. Appears this was missed AGAIN by OBs postpartum per the report of repeated severe HTN without mention of further labetalol dosing.
- Shaking in a PreE woman at the END of a CS isn't a panic attack. And Anes didn't think it was just shivering bc she gave midazolam. Likely focal/partial seizure if not obvious tonic-clonic. (Legs won't shake under neuraxial)
- ***Devastating case for everyone involved, ? missing data? may not have been preventable & always easier to critique in hindsight.***

15. Brain Bleed During C-Section. *Anesthesiology Malpractice*. August 6, 2026.

ECLAMPTIC SEIZURES

- 33% of eclamptic seizures occur at term, intrapartum, or within 48h of delivery.
  - PP eclampsia (> 48 h after delivery) increasingly reported (11- 55% of cases)[6]

SEIZURE MAY BE FIRST SIGN

NO HTN, NO PROTEINURIA

A significant % of women (20–38%) **do not** demonstrate the classic signs of PreE (HTN or proteinuria) before the seizure episode

Thus, the notion that PreE has a natural linear progression from PreE without severe features → PreE with severe features → eclamptic convulsions…***is inaccurate***.[14]

HTN at seizure onset[6]

20–54% severe: > 160 / 110

30–60% mild: 140-160 / 90-110

16% ABSENT

6. Merlino et al. *J. Clin. Med.* 2023
14. Espinoza et al. *ACOG PRACTICE BULLETIN No 222.* 2018

ECLAMPTIC SEIZURES

ACOG: There is **no consensus** on prophylactic MgSO4- for seizure prevention in gestational HTN ***or PreE without SF***

Rationale:

Absolute seizure risk low in ~1:200 asymptomatic PreE pts

vs

~4:200 in symptomatic pts: severe HA, blurred vision, photophobia, hyperreflexia, epigastric pain

- treating 100-129 mild PreE pts to prevent 1 seizure

vs

- treating 36 PreE SF pts to prevent 1 seizure

Therefore routine MgSO4- use is weighed vs side effects (5% higher c/s rate, maternal sfx, etc)



- 2021 Meta-analysis did NOT show clear increased risk of PPH in C/S with intra-op $MgSO_4$- . (41,190 total pts, 10,565 received $MgSO_4$-.)
- Some observational studies did, but RCTs did NOT. [53]
- May have ↑ EBL in VD, but not shown to be true in C/S.[54]

14. Espinoza et al. *ACOG PRACTICE BULLETIN No 222.* 2018
53. Pergialiotis et al. *European J of Obs & Gyn and Reproductive Biology.* 2021
54. Young, et al.. *The journal of maternal-fetal & neonatal medicine.* 2022

ECLAMPTIC SEIZURES

Usually (~89%) present as generalized tonic–clonic seizures lasting ~ 60 seconds[6]

BUT can *also* present as *Focal or Partial* seizures (~8%)

- localized twitching (eg: leg/arm twitching)
- blank stare
- subtle involuntary movements
- can be unilateral
- altered awareness[16]

Convulsions may be preceded by:

persistent frontal or occipital HA, blurred vision, photophobia, epigastric or RUQ pain & altered LOC[6]

6. Merlino et al. *J. Clin. Med.* 2023
16. Saira khan et al. *Pak. J. of Neurol. Surg.* 2025

ECLAMPTIC SEIZURES

Most women with typical eclampsia do not need neuroradiological testing

HOWEVER, *some* PP eclamptic pts **<u>should</u>** undergo comprehensive diagnostic eval (preferably including **MRI**)

IF:

- ✓ focal neuro deficits
- ✓ persistent visual disturbances
- ✓ s/s refractory to $MgSO_4$- and anti-HTN TX

<u>Findings in PreE & eclampsia:</u>

infarction, hemorrhage, vasoconstriction, dissection, both vasogenic & cytotoxic edema.

Neuroimaging may reveal RCVS, which can develop craniocervical arterial dissection.

6. Merlino et al. *J. Clin. Med.* 2023

Eclampsia Algorithm

Known or suspected pregnancy
OR
Possible pregnancy within the last 6 weeks

Initial Intervention: Presumed Eclamptic Seizure

- Perform usual seizure patient care
- If pregnant, try to position patient in left lateral decubitus position, head of bed down
- Prepare to initiate medical therapy
- Request immediate obstetric consultation

Administer Magnesium Sulfate

First-line therapy for suspected eclamptic seizure

Magnesium Initial Treatment

1) **Loading dose:** 4–6 g IV over 20–30 minutes, then start maintenance dose
2) **Maintenance dose:** 1–2 g/h

If no IV access (not available or cannot be established):

- Administer magnesium sulfate intramuscularly (IM) — 10-g loading dose (5 g in each buttock) followed by 5 g IM every 4 hours
- The medication can be mixed with 1 mL of a 2% xylocaine solution to reduce discomfort
- There are no data on IO administration of magnesium sulfate in eclamptic seizures

If altered renal function (creatinine ≥ 1 mg/dL), maintenance dosing of magnesium will need to be adjusted. Consult pharmaceutical reference or request guidance from obstetric consultant for specifics.

Persistent or recurrent seizure after magnesium sulfate loading dose:

Continue magnesium sulfate maintenance infusion, administer one of the following medications, and prepare for possible intubation

Preferred next medication class: benzodiazepines

- **Lorazepam** 4 mg IV over 3–5 minutes, **OR**
- **Diazepam** 5–10 mg IV slowly
- **If no IV access**, can administer **midazolam** 10 mg IM

If still seizing:

- **Fosphenytoin** 20 mg PE/kg IV at 150 mg PE/min

If persistent,

- **Levetiracetam** 60 mg/kg IV, max 4,500 mg
- Consider intubation with **propofol** and consultation with neurology, anesthesia, critical care, or maternal–fetal medicine.

Resolution of Seizure

1) **Assess BP — if SBP ≥ 160 or DBP ≥ 110, initiate Acute Hypertension Algorithm**
2) **OB evaluation ASAP**
3) If seizure responds to magnesium sulfate and the patient is maintained on magnesium sulfate (and unable to be urgently transported to an obstetric unit for further evaluation and treatment):
   a. Continue magnesium sulfate infusion at 1–2 g/h
   b. Monitor serum magnesium levels every 4 hours (first level at 4 hours after therapy initiated — therapeutic range: 4.9–8.5 mg/dL)
   c. Observe for possible toxicity ***(see Box 1)***
4) Maintain magnesium sulfate infusion for at least 24–48 hours after the last seizure or after delivery, whichever is later
5) Obtain head CT
6) Perform thorough neurological examination to evaluate for focal deficits
7) Preparation should be made for delivery, as applicable; mode and timing of delivery depend on obstetric circumstances
8) For potential magnesium toxicity:
   a. **If serum magnesium > 9.6 mg/dL, the infusion should be stopped**
   b. Re-start when the level decreases to <8.4 mg/dL
   c. Calcium gluconate or calcium chloride should be readily available for impending respiratory depression
      - Calcium gluconate: 10% solution, 10 mL (1,000 mg or 1 g) IV over 3 minutes
      - Calcium chloride: 10% solution, 5 mL (500 mg) IV over 5–10 minutes

Box 1

Serum Magnesium Concentration

Range (mg/dL)	Effect
4.9–8.5	Therapeutic range for seizure prophylaxis
8.5–12.2	Loss of deep tendon reflexes
12.2–15.8	Respiratory paralysis
>18.2	Altered cardiac conduction
>30	Cardiac arrest

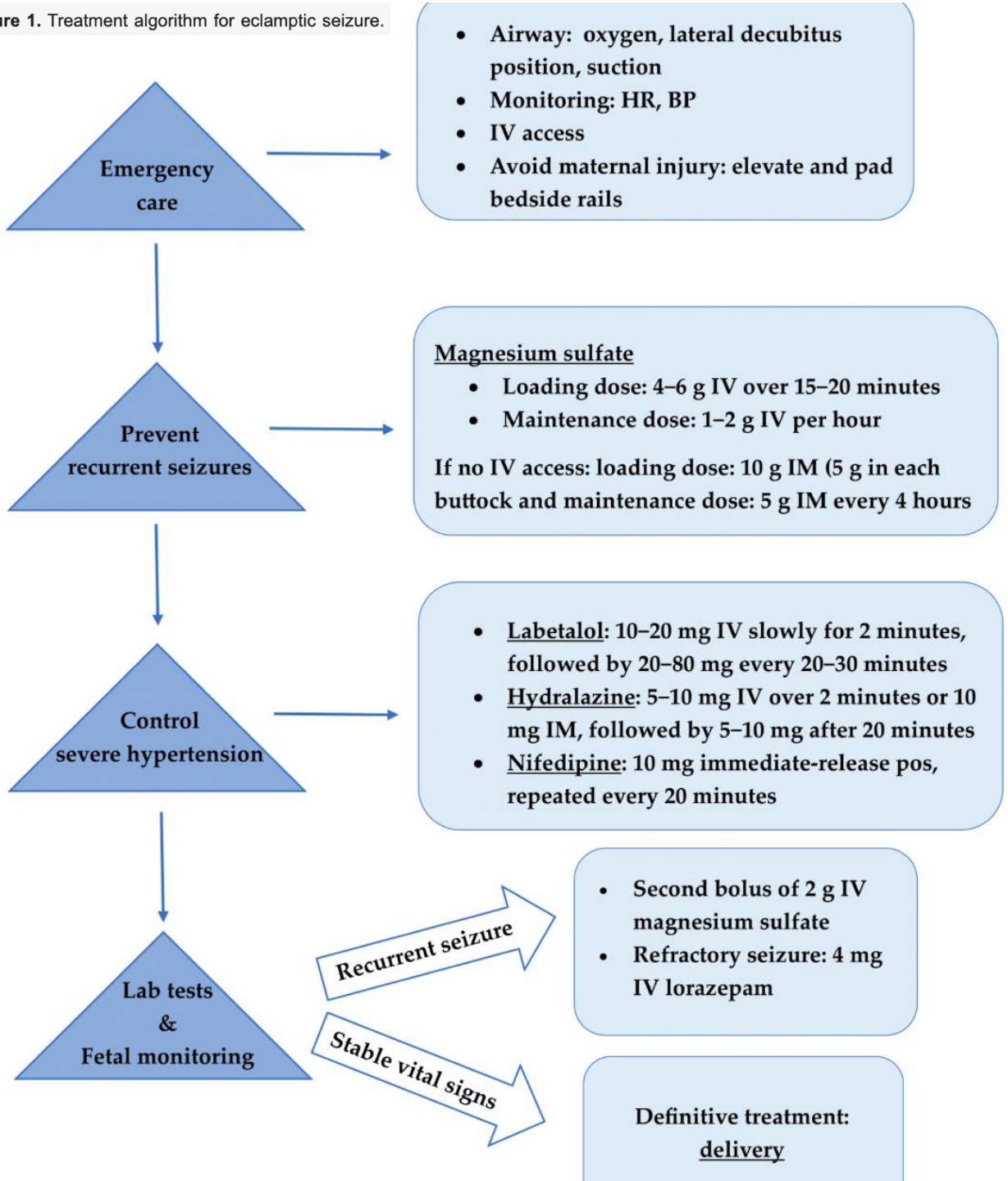
Data from Chau AT. Magnesium toxicity. In: McEvoy MD, Furse CM, editors. Advanced perioperative crisis management. Oxford Academic; 2017. p. 431-5.

ACOG The American College of Obstetricians and Gynecologists | AAENP American Academy of Emergency Nurse Practitioners | American College of Emergency Physicians Advancing Emergency Care | ENA Emergency Nurses Association | Society of Emergency Medicine Physician Assistants

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17. Initial Intervention: Presumed Eclamptic Seizure Magnesium Initial Treatment. *ACOG*. 2023

Figure 1. Treatment algorithm for eclamptic seizure.



DEFINITIVE prevention for subsequent seizures = **$MgSO_4$**

Only ~ 10% of eclamptic women develop a 2nd seizure after receiving $MgSO_4$. [6]

18. Katsi et al.. *J Cardiovascular Dev & Disease.* 2024
6. Merlino et al. *J. Clin. Med.* 2023

How to Use Mag Sulfate

➢ Mag sulfate is DEFINITIVE TX of choice for seizure prophylaxis

•MOA: NMDA receptor antagonism, BBB stabilization, systemic vasodilation → rapid BP reduction, & prevention or reversal of cerebral vasospasm

- **4–6g IV loading dose** over 20–30 min
  - Maintenance gtt: 1-2g/ hr (adjusted if renal impairment)
  - Continue mag for 24 hrs postpartum

IM dose: **5g/10mL** each side…OUCH

- **IM option:**
  - **10g loading dose** (10g split into 5g IM in **b/l ventrogluteal sites**)
    - followed by 5g Q4hr IM
  - Use if IV access limited - add 1 mL 2% lido if possible – its **painful**



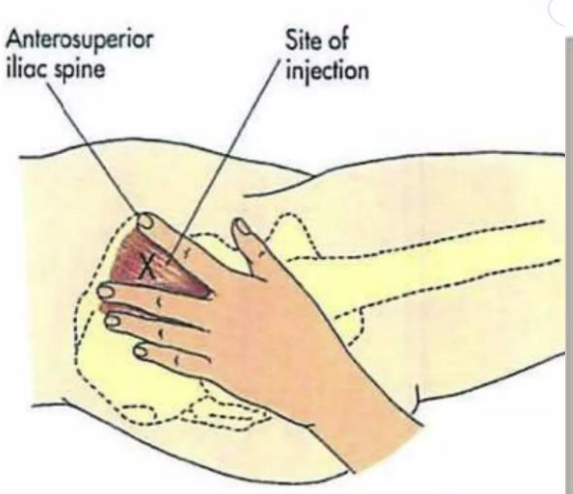
•**Recurrent seizures**

- Additional dose of 2-4 g can be infused over 5 minutes
- More mag before benzos or additional prophylactics

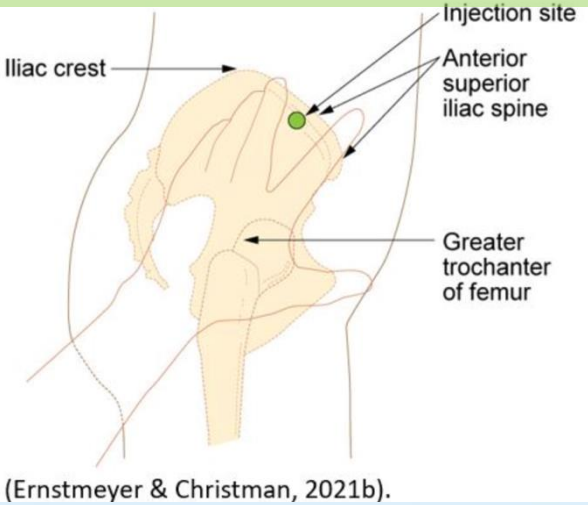
19. Weinstock D. *The ObG Project* . 2023.

IM $MgSO_4$- site: Ventrogluteal, 5mg on *each side*









(Ernstmeyer & Christman, 2021b).







Other Seizure Prophylaxis Meds

- **Mag sulfate is superior to diazepam, phenytoin & lytic cocktail (chlorpromazine, promethazine, pethidine) in significantly reducing risk of seizure recurrence**
  - Diazepam or lorazepam *does* stop/shorten seizures, *but adds risk of maternal apnea and/or cardiac arrest*

- Diazepam & phenytoin may be considered if:
  - Pt on these meds to treat epilepsy
  - $MgSO_4$- contraindicated:
    - Myasthenia gravis
    - Hypocalcemia
    - Moderate-to-severe renal failure
    - Cardiac ischemia
    - Heart block
    - Myocarditis[19]

LORAZEPAM:
2 - 4 mg IV repeat x 1 after 10 - 15 min

DIAZEPAM:
5 -10 mg IV Q5 to 10 min
max dose 30 mg.

IM dosing not recommended for either [7]

19. Weinstock D. *The ObG Project* . 2023.
7. Dennis et al. *Anesthesiology*. 2025

MAG TOXICITY

- **Respiratory Depression:**
  - R/o mag tox w/ DTRs – test biceps if neuraxial LE blockade still in place.
  - Tx: 10cc of 10% calcium gluconate (1g) over 10 min.



SpO2 drop DDX:

- If PP c/s: consider time since IT morphine, if administered.
  - 6-12h resp depression biphasic response.
  - Other opioid/drug toxicity? Consider impaired liver & renal fxn*
  - Pulmonary edema? → HF/PPCM? Sepsis?
- Consider concealed hemorrhage
  - Mag has tocolytic properties
  - PreE & HELLP have high risk of coagulopathy & DIC
- AMS/Neuro changes:
  - Eclampsia?
  - Sepsis?
  - Intracranial pathology?
  - L.A.S.T?

Post-Seizure DELIVERY in ECLAMPSIA – Neuraxial vs GA

Neuraxial SAFE in **STABLE** patient.

- ✓ Glasgow coma score >/= 14
- ✓ Not requiring *rapidly acting* anti-HTN meds
- ✓ PLT > 100k
- ✓ Cooperative
- ✓ Normal FHR
- ✓ No additional maternal or fetal complications.

Neuraxial benefit:

- ➢ Enables prompt and serial neuro/mental status evals
- ➢ Avoids the HTN risks of GA and surgery.

UNSTABLE → likely GA

- ✓ Patient unconscious or uncooperative
- ✓ Refractory seizures
- ✓ Uncontrolled HTN
  - slow dosed-epidural? *chloro v lido/epi?

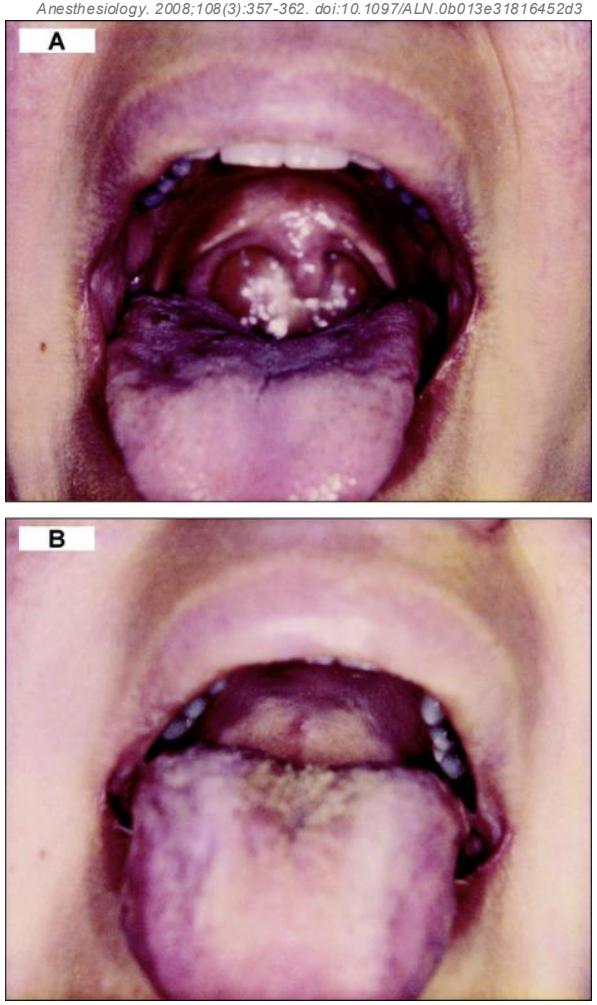
* *If eclamptic pt requires ETT, neuroimaging before extubation may be required to eval for hemorrhagic stroke or other conditions that may preclude extubation.*

7. Dennis et al. *Anesthesiology*. 2025

Delivery Planning: The Maternal Airway

- ✓ AIRWAY SWELLING, + potential coagulopathy makes PreE, Elampsia, HELLP higher risk for difficult airway.
  - ➢ Airway swelling exacerbated by **PreE, labor, & pushing***.[20]
- ✓ Assess ability to **tolerate C/S positioning**:
  - ➢ If unable to lie flat for c/s (↑ SOB, ↑ FiO_2, ↑ agitation)
    - ➢ May need ETT, as PP fluid shifts can acutely worsen condition.
      - ➢ Controlled intubation before emergency occurs.[21]
        - ➢ ***Airway positioning before case start****

Anesthesiology. 2008;108(3):357-362. doi:10.1097/ALN.0b013e31816452d3



↑ Airway changes in Labor ↑
Same woman before & after labor.

20. Kodali et al, *Anesthesiology*. 2008
21. Meng ML, Arendt KW. *Anesthesiology*. 2021

More GA / Airway Considerations

- *** Consider ketamine & versed immediately if pt feels pain from failing/fading neuraxial block, while waiting for epidural re-bolus to take effect.**

- MgSO4- effect on smooth muscle (GI system) can contribute to even slower gastric emptying.
  - Additional anti-emetics may be needed for N/V caused by MgSO4- to reduce ICP changes from vomiting, especially in presence of thrombocytopenia



IF GA UTILIZED:

- Always VL if possible – gentler on airway tissues & greater 1st pass success.
- Careful, gentle OGT placement – avoid any oropharyngeal trauma/swelling.
- MUST ablate HTN response to **INTUBATION & EXTUBATION**
  - Identified as a cause of direct maternal mortality
  - Can use: alfentanil, fentanyl, remifentanil, and esmolol.
    - Recommended to use the drug(s) with which you are most familiar.
  - Avoid complications on emergence: HTN, aspiration & acute pulmonary edema/NPPE.

3. Dennis AT. *Anaesthesia.* 2012

SUCCS vs ROC in RSI

Front Med (Lausanne). 2022 Feb 9;9:717477. doi: 10.3389/fmed.2022.717477

Impact of Succinylcholine vs. Rocuronium on Apnea Duration for Rapid Sequence Induction: A Prospective Cohort Study

Lijun Tang [1,†], Xiao Zhao [2,†], Shitong Li [2], Lina Huang [2], Jinbao Li [2], Lianhua Chen [1,*], Shiwei Huang [2,*]

- 2022 PCS compared non-hypoxic apnea duration in RSI comparing 3 groups (N=265)
- Measured from $ETCO_2$ waveform apnea until SpO_2 → 95% (T95) and 90% (T90)
  - 1.5 mg/kg Succs (n=90)
  - **1.0 mg/kg Succs (n=83)**
  - **1.2 mg/kg Rocuronium (n=92)**
- **COMPARED:**
  - 1.5 mg/kg Succs vs **1.0 mg/kg Succs**
  - 1.5 mg/kg Succs vs **1.2 mg/kg Rocuronium**

Useful consideration in OB where pts have decreased FRC and higher potential for difficult and failed airways*

RESULTS

- **Succs 1.0 mg/kg** produced a **50.72 sec** longer safe apnea time to T90 than Succs 1.5 mg/kg
  - (95% CI 7.60–94.38; P=0.015) and **48.09 sec longer to T95** (95% CI 7.11–89.07; P=0.012).
- **Rocuronium 1.2 mg/kg** produced a **56.84 sec** longer safe apnea time than Succs 1.5 mg/kg
  - (95% CI 16.24–97.44; P=0.003) and **50.57 sec longer to T95** (95% CI 12.58–88.57; P=0.003).

- **Conclusion:** Authors suggest **Rocuronium 1.2 mg/kg** or **lower dose Succs (1.0 mg/kg)** may be preferable for RSI
  - Both prolong safe apnea time vs higher 1.5 mg/kg Succs dose.
  - **Likely mechanism: higher-dose Succs ↑O_2 consumption via fasciculations → faster desaturation.**

25. Tang et al. *Front Med (Lausanne)*. 2022

Can Intraperitoneal 3% Chloroprocaine help avoid GA in some scenarios?

Werntz et al. 2018 single center case series: 2479 c/s, 32 pts received IPLA

- **14/32 women (43.8%)** required epidural or systemic medications within the first 15 min after IPLA, suggesting IPLA didn't provide complete analgesia.
- **6 women (18.8%)** received no other meds in the 15 min before or after IPLA.
- ZERO conversions to GA needed

TECHNIQUE:

- **20-40cc** 3% 2-Chloroprocaine
- Uterus retracted caudally to expose IP space & chloroprocaine poured in
- Two sides of Pfannenstiel incision grasped by surgeon & solution agitated to spread throughout abdomen until pt stated pain relief
    - (~ 1–2 min, always <5 min)
- Solution suctioned out to limit systemic absorption and risk of LAST
    - ➢ *proven unnecessary in co-author's f/u 2022 study of serum LA []s*

Table 3 Pain scores before and after intraperitoneal local anesthetic

Patient #	NPRS immediately before IPLA	NPRS immediately after IPLA
1	10	3
2	9	0
3	10	1
4	7	0
5	10	0
6	7	0
7	6	0
8	8	0
9	10	6
10	8	0
11	10	0
12	10	2
13	7	0
14	Not obtained	Not obtained
15	Not obtained	Not obtained
16	Not obtained	Not obtained
17	8	0
18	Not obtained	Not obtained
19	Not obtained	Not obtained
20	Not obtained	Not obtained
21	10	0
22	Not obtained	Not obtained
23	Not obtained	Not obtained
24	Not obtained	Not obtained
25	Not obtained	Not obtained
26	Not obtained	Not obtained
27	10	5
28	10	2
29	Not obtained	Not obtained
30	Not obtained	Not obtained
31	Not obtained	Not obtained
32	Not obtained	Not obtained

22. Werntz M, Burwick R, Togioka B. *Int J of Obstetric Anesthesia.* 2018

Can Intraperitoneal 3% Chloroprocaine help avoid GA in some scenarios?

- **20-40cc 3% Chloroprocaine**
  - + 0-40mL NS irrigation into sterile basin
- Spray directly into field/gutters
- **Wait 2-3 min**, can suction out or leave in



Gives ~20 min operative time of surgical anesthesia



May be worth trying in sketchy airway



IMO:
Combine with immediate ketamine & versed +/- fent while waiting for block to set up.
Prop risks obstruction/apnea and rapid desat

22. Werntz et al. *Int J of Obstetric Anesthesia.* 2018
23. Togioka et al. *Anesthesia & Analgesia.* 2022

Can Intraperitoneal 3% Chloroprocaine help avoid GA in some scenarios?

Pharmacokinetics and Tolerability of Intraperitoneal Chloroprocaine After Fetal Extraction in Women Undergoing Cesarean Delivery

Brandon M. Togioka[†], Yalda Zarnegarnia[*], Lisa A. Bleyle[‡], Dennis Koop[‡], Kathleen Brookfield[†], N. David Yanez[§], Miriam M. Treggiari[‖]

Authors and Affiliations >

Anesthesia & Analgesia 135(4):p 777-786, October 2022. | DOI: 10.1213/ANE.0000000000006064



- 2022 study demonstrated no/low risk of LAST using IPChl
- N = 15
- Togioka et al compared **40 ml** of **3%** (n=5), **2%** (n=5), **1%** (n=5) **Chloroprocaine**
- Drew blood 1, 5, 10, 20, & 30 min after dose to to assess plasma LA []
- Peak []: 5 min post –dose
  - Highest in 40mL 3% (1200mg) : 79.9 µg/kg
    - Below predefined safe threshold of 970 µg/kg
    - Below levels assc w clinical s/s (2.6–2.9 mg/kg)
  - Similar [] to epidural absorption
- $T^1/_2$ 5.3 min (4-4.6-6min)
- IP chloroprocaine dose ≤1200 mg, given after fetal extraction, is well tolerated during c/s

23. Togioka, et al. *Anesthesia & Analgesia.* 2022

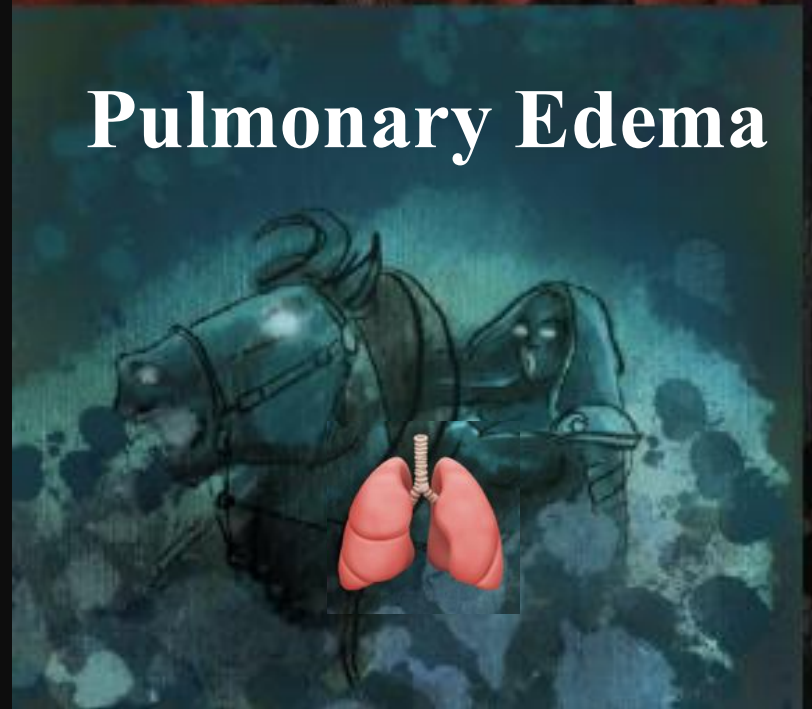
HYPERTENSION

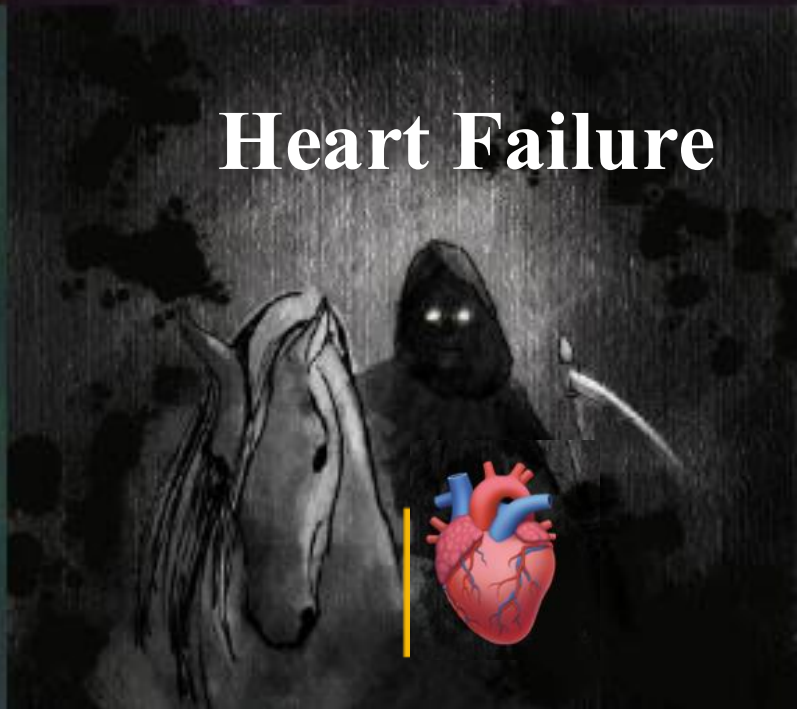


THE FOUR HORSEMEN OF THE HYPERTENSION APOCALYPSE









Severe HTN vs HTN Crisis

Severe HTN: SBP ≥160 mmHg or DBP ≥ 110mmHg

$MgSO_4$- running ALWAYS in SF*

HTN Crisis: SBP >180mmHg = **medical emergency** requiring immediate TX

- Assc w/ increased risk of ICH
  - reducing severe HTN ↓ mortality
  - TX: labetalol (PO or IV), PO nifedipine & IV hydralazine

Primary Concern:
Maternal Hemorrhagic Stroke



- **Avoid precipitous falls in BP**
  - **can cause maternal or fetal complications as BP falls below critical perfusion thresholds.**
- ***A-line is completely reasonable in cases of uncontrolled HTN, esp if neuro symptoms.**
  - **Goal: reduce BP at rate of 10–20mmHg every 10–20min.**
    - **SBP 140–150mmHg DBP 80–100mmHg[3,7]**
    - **Gentle with pressors – can be HYPERresponsive to standard IVP doses[7]**

- Controlled epidural dose for c/s – epidural fent 100mcg can improve block density
- Can consider test dose 50-100mcg fent vs potential IV epi in uncontrolled HTN, or TD 1cc at a time and initial loading dose of 3% 2-Chloroprocaine for reduced LAST risk in IV catheter.[7]

3. Dennis AT. *Anaesthesia*. 2012
7. Dennis AT et al. *Anesthesiology*. 2025

Monitoring Considerations in Obesity

- **In pts with high BMI, A-line may be needed due to the unreliability of NIBP**
  - Significantly longer time may pass between onset of sympathectomy and delivery of baby given surgical access difficulties of large pannus
  - Accurate and frequent BP monitoring needed to ensure adequate uteroplacental perfusion prior to delivery

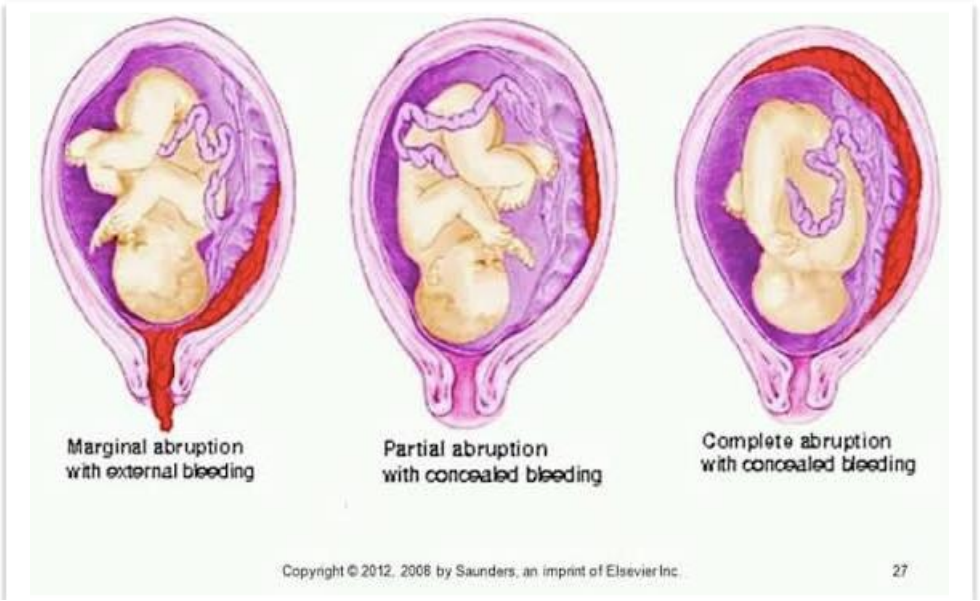
Airway positioning:

- ramped
- able to extend neck into sniffing position
- breast tissue displaced off neck

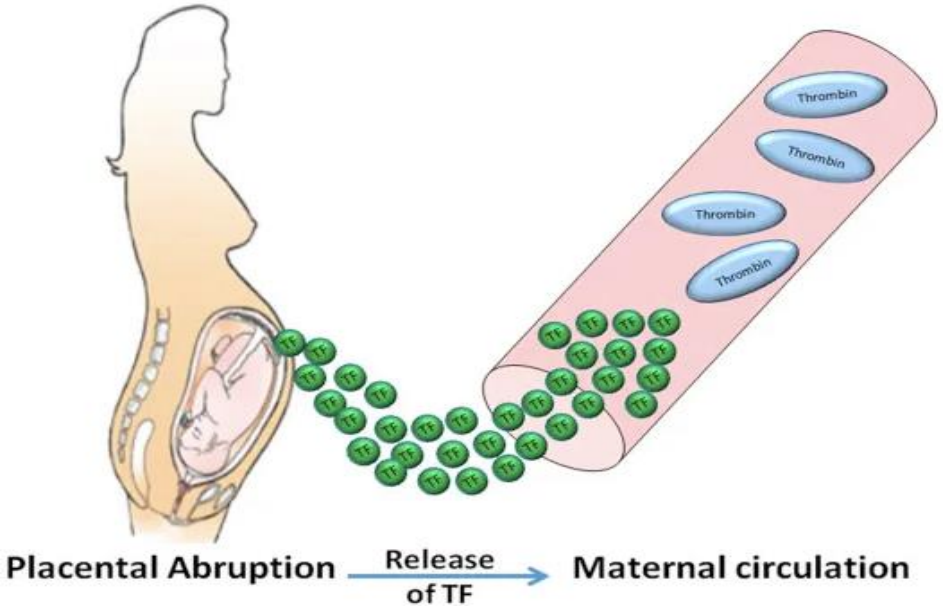
Proactive **2nd IV placement*** before emergency occurs

In **hemorrhage**:
consider Intrauterine IM route for uterotonics by OBGYN if significant adipose tissue may exceed standard IM needle depth.

Placental Abruption & Hemorrahge



- **Coagulation status assessment imperative if abruption suspected**
- **Abruption can be caused by PreE**
  - **Hypovolemia from hemorrhage can mask HTN[3]**



https://obgynkey.com/disseminated-intravascular-coagulation-in-pregnancy-insights-in-pathophysiology-diagnosis-and-management/

PP hemorrhage risk significantly higher in preE:

- emergency surgery
- maternal anemia
- thrombocytopenia or HELLP syndrome,
- concurrent aspirin therapy
- increased body mass increasing surgical complexity and operating time
- presence of HTN itself.[7]

3. Dennis AT. *Anaesthesia*. 2012
7. Dennis AT et al. *Anesthesiology*. 2025

CARDIOPULMONARY COMPLICATIONS





PreE and Heart Failure

- Well-established that PreE can cause diastolic dysfunction
  - Especially early-onset PreE < 34wks
    - Increased incidence of severe LVH, diastolic dysfunction, and higher BNP levels, compared with late-onset PreE. [25,26]

- ***Despite a brief time period of HTN*, the maternal heart can still adapt to acute and transient ↑ SVR with remodeling and concentric hypertrophy.**[26]
  - In fact, *most women with PreE undergo adaptive myocardial remodeling from ↑SVR*, ***but a small subgroup demonstrate signs of overt decompensation*.**

25. Melchiorre K, Sutherland GR, Watt-Coote I, Liberati M, Thilaganathan B., *Hypertension in Pregnancy*. 2012
26. Borges VTM, Zanati SG, Peraçoli MTS, et al. *Ultrasound in Obstetrics & Gynecology*. 2018

PreE and Heart Failure

- Compared with normal cohorts, PreE has 71% increased risk of CVD mortality
  - 2.5x higher risk of CAD
  - 4x higher risk of heart failure.[27]
    - PreE and PPCM both exhibit upregulation of antiangiogenic and vasculotoxic hormones secreted by placenta[28]


https://www.uchealth.com/en/media-room/patient-stories/heart-failure-after-pregnancy-life-saving-lvad-placement

Madi

17y/o

Emergent c/s 25w5d for severe PreE

Decompensated HF: dx PPCM

IABP → ECMO → RVAD & LVAD

Remains with LVAD

27. Mehta LS, Warnes CA, Bradley E, et al. *Circulation*. 2020
28. Lewey et al. *Hypertension*. 2020.

PPCM has higher rates of Preeclampsia

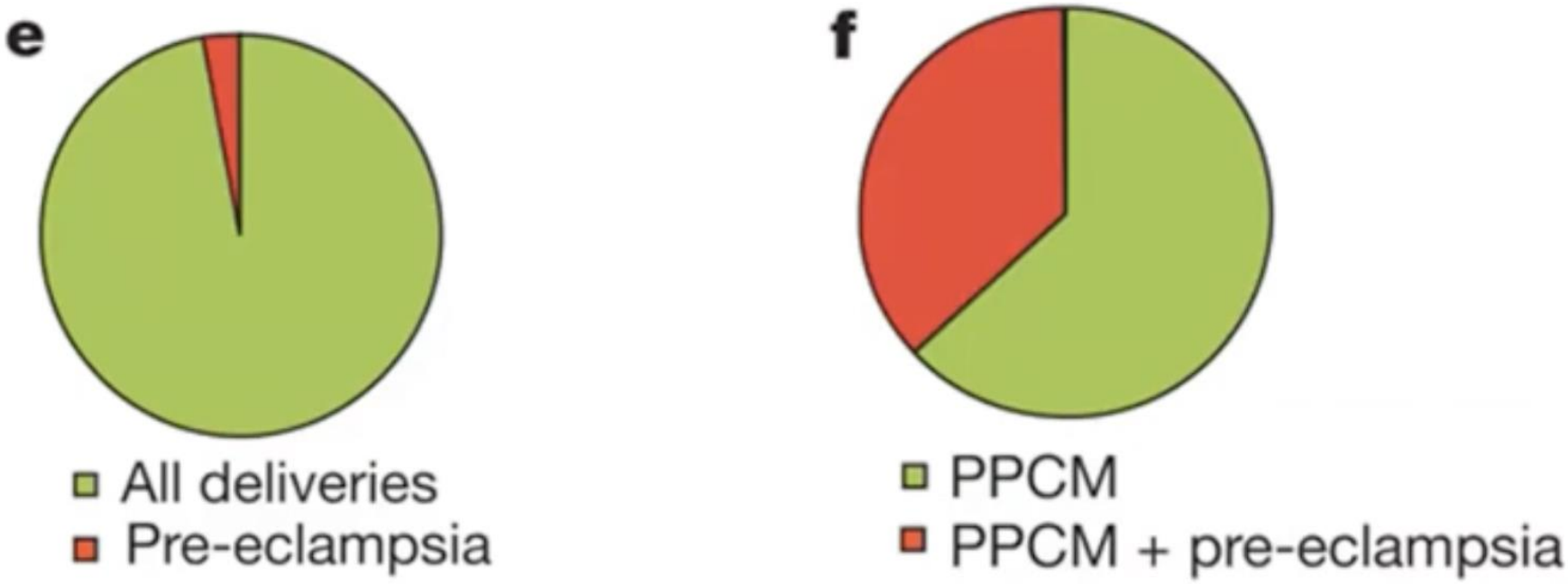


Figure 6e-f. Prevalence of pre-eclampsia among all deliveries (**e**) and among women with PPCM (**f**) at Harvard teaching hospitals in the previous 9 years

29. Patten et al. *Nature*. 2012

Cynthia

G5P4

“Two weeks after birth, I was back in the hospital with my BP at 215/127.

…I couldn't breathe. Every time I lay down, I felt as though I was drowning.”

EF 25%
Ext defib
Medically managed
Full recovery



PreE and Heart Failure with Preserved EF

9.5 % of PreE women w/ severe features found to have HFpEF

Almost 1 in 10!

- SOB & pulmonary edema are common presenting signs of HFpEF
  - **Often precipitated by excess IV fluids → pulmonary edema**

7. Dennis AT, Xin A, Farber MK. *Anesthesiology.* 2025

PreE and Heart Failure with Preserved EF

- Prior to decompensation (↓ EF), TTE on PreE women often looks…
  …*normal*… with normal to increased CO, EF & contractility

- Formal ECHO if symptomatic:
  - SOB, cough, orthopnea, etc.. r/o pulm edema/effusions

- Further investigation often shows:
  - *Diastolic dysfunction*[7]**
  - Increased pericardial effusions, and pleural effusions
  - Increased LV wall dimensions compared to healthy parturients[32]

7. Dennis et al. *Anesthesiology.* 2025

National Partnership for Maternal Safety

Maternal Early Warning Criteria (MEWC)

- To aid in faster recognition, evaluation, diagnosis, and treatment of signs of developing critical illness, to reduce preventable maternal death.

If (+): Low threshold to obtain further imaging: TTE, CXR, LUS, ECG

Systolic BP (mm Hg)	<90 or >160
Diastolic BP (mm Hg)	>100
Heart rate (beats per min)	<50 or >120
Respiratory rate (breaths per min)	<10 or >30
Oxygen saturation on room air, at sea level, %	<95
Oliguria, mL/hr for ≥2 hours	<35
Maternal agitation, confusion, or unresponsiveness; Patient with preeclampsia reporting a non-remitting headache or shortness of breath	

30. Mhyre JM, D'Oria R, Hameed AB, et al. *Obstetrics & Gynecology*, 2014

IDENTIFYING HEART FAILURE IN PREGNANCY

ACOG Practice Bulletin No. 212 *Pregnancy and Heart Disease* contains a table of signs and symptoms which, if reported, require cardiac evaluation ASAP.

If (+): Low threshold to obtain further imaging: TTE, CXR, LUS, ECG

Vital Signs	Physical Exam Signs	History and Symptoms
Heart rate ≥ 120 beats/min	Jugular venous pressure visible 2 cm above clavicle at 45°	History of cardiovascular disease
Systolic blood pressure ≥ 160 mm Hg	Loud systolic murmur or S4	Shortness of breath at rest, paroxysmal nocturnal dyspnea, orthopnea, refractory pneumonia, or bilateral chest infiltrates on chest radiography
Symptomatic low blood pressure	Wheezing	Chest pain at rest or minimal exertion
Respiratory rate ≥ 25 breaths/min	Lung crackles	Exertional or unprovoked syncope or palpations associated with near syncope or syncope
Oxygen saturation < 95%	Marked peripheral edema	Extreme fatigue

Modified from American College of Obstetricians and Gynecologists.[14]

21. Meng ML, Arendt KW. *Anesthesiology*. 2021

J Midwifery Womens Health. 2016 Jul;61(4):467-73. doi: 10.1111/jmwh.12448. Epub 2016 Jun 10.

Women's Experiences Being Diagnosed With Peripartum Cardiomyopathy: A Qualitative Study

Rebecca L Dekker, Christine H Morton, Paula Singleton, Audrey Lyndon

PMID: 27285199 DOI: 10.1111/jmwh.12448

~40%

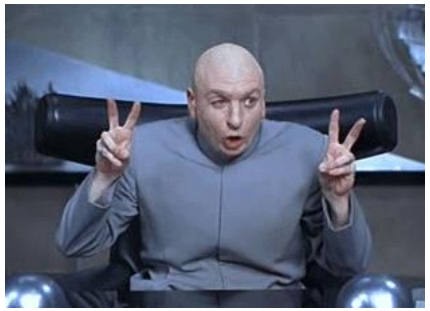
of women experienced **symptom dismissal** by health care providers

Most commonly reported symptoms:

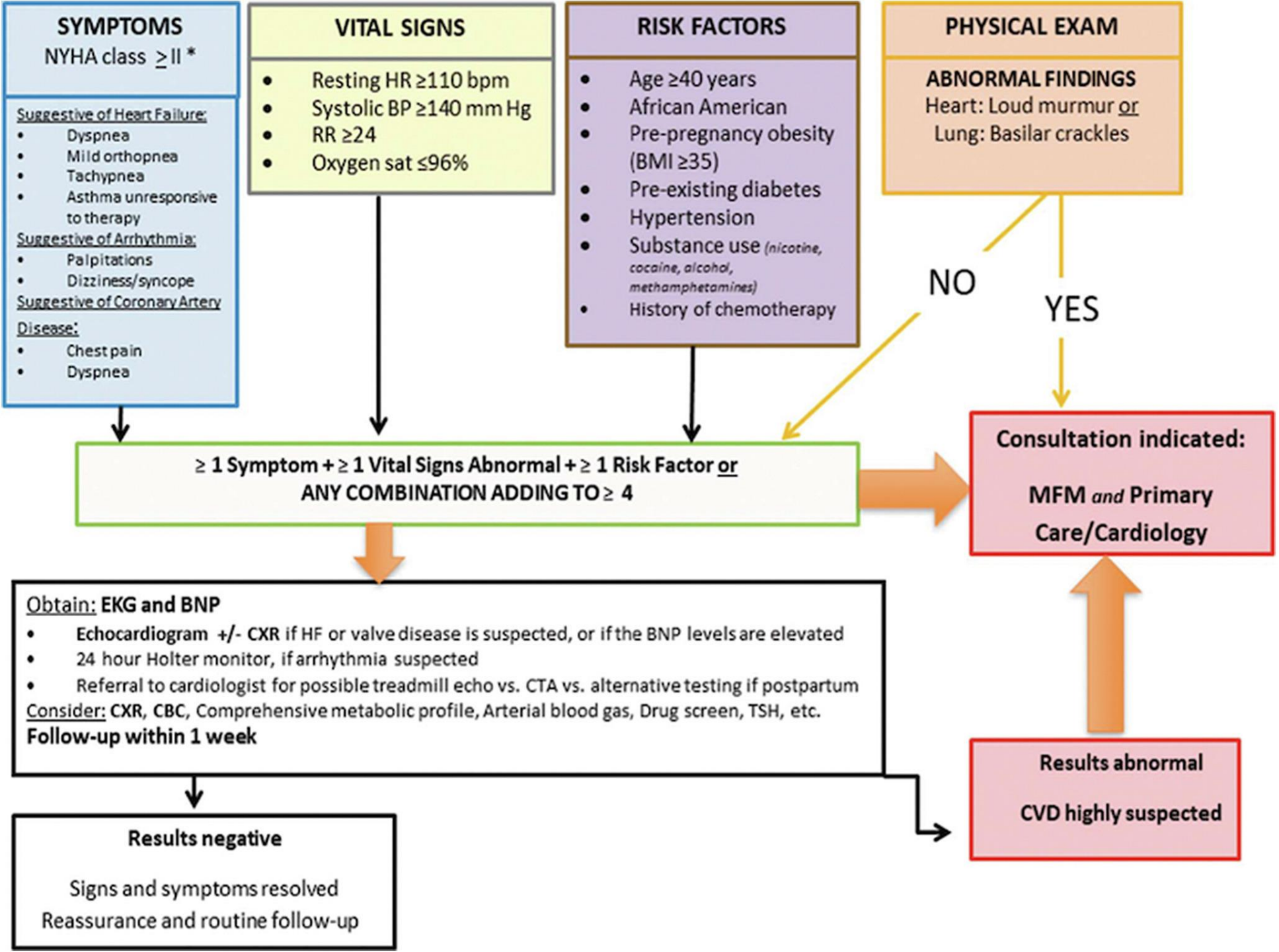
- ***Extreme SOB***
- ***Orthopnea***
- ***Tachycardia***
- ***Palpitations***
- ***Chest pain***
- ***Cough***
- ***Edema***

25% of women initially **misdiagnosed**:

- Asthma
- Pneumonia
- Influenza
- Common cold
- Fluid in lungs from $MgSO_4$
- Gallbladder disease
- Panic attack
- Stress
- Postpartum depression
- "New mom" anxiety



31. Dekker RL et al. *J of Midwifery & Women's Health*. 2016



AJOG: Women with risk factors: **AMA, obesity, CHTN, DM, *or other risk factors for PreE* will benefit from baseline cardiac eval *including ECG & ECHO.***

32. Roberts et al., *AJOG*. 2023

BNP & NT-proBNP

Reference Intervals in Pregnancy:

- **BNP: < 50** pg/ml
- **NT-proBNP:**
  - TM 1&2: **< 200** pg/ml
  - TM 3: **< 150** pg/ml [33, 39]

- **NT-ProBNP** : inactive portion of split BNP protein with longer $Et^1/_2$ = higher plasma levels.
  - **Benefit = *EASIER PROCESSING:*** very stable, can sit out at room temp; whereas BNP is an unstable diva that needs ice, special handling, and quick processing before protein degrades, for accurate results.

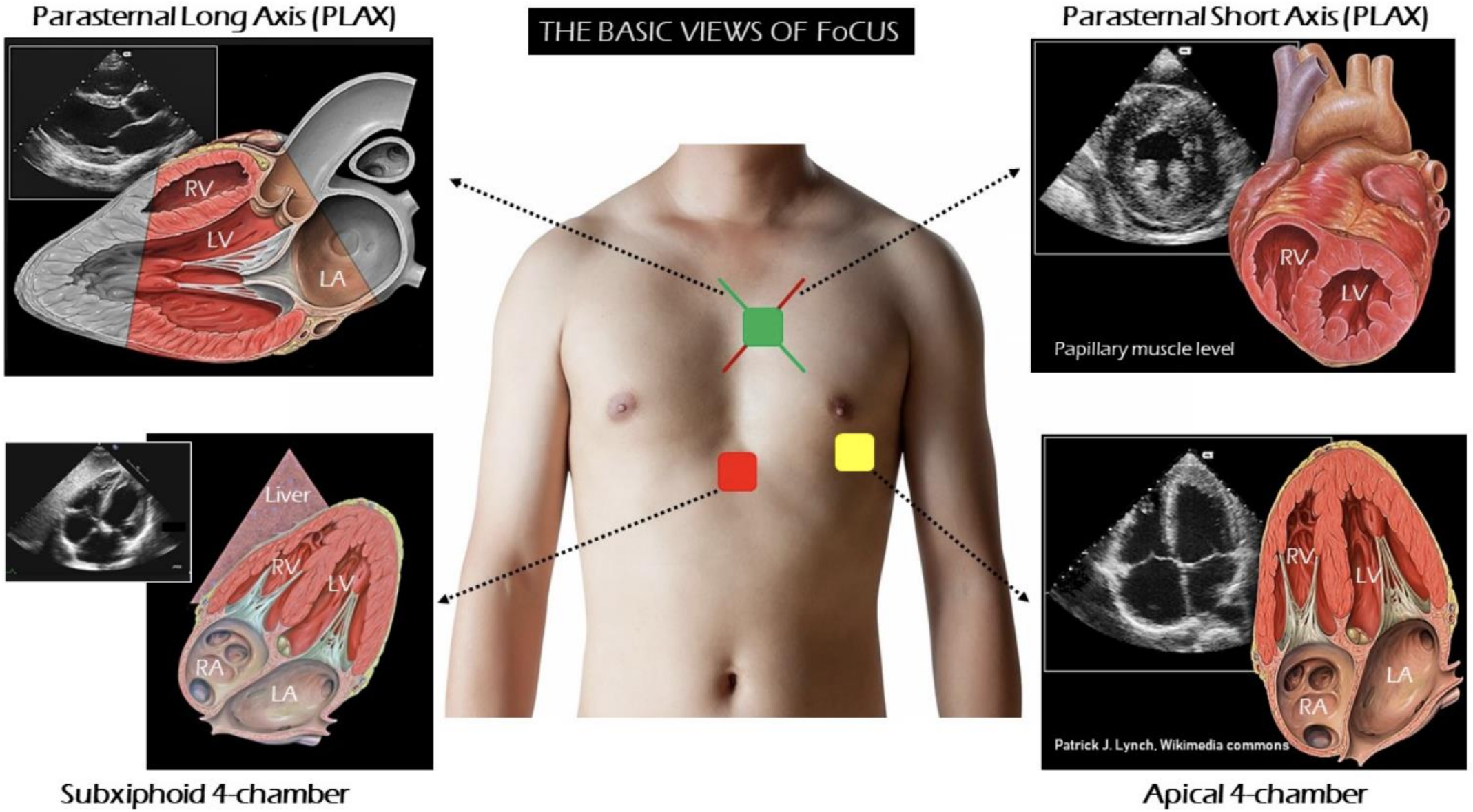
- BNP =/↓ in pregnancy, despite ↑ plasma volume; as normal adaptations of cardiac remodeling and ↓ SVR *leave central filling pressures unchanged,*[35] and both plasma dilution and ↑ GFR will ↓ circulating levels. [33]

- **Pregnant women have LOWER BNP thresholds for further cardiac evaluation** than the traditional guideline of BNP < 100 to rule out HF in non-pregnant patients.

- **BNP ↑ in PreE**... *as a marker of diastolic dysfunction.*[33]

33. Borges VTM, Zanati SG, Peraçoli MTS, et al. *Ultrasound in Obstetrics & Gynecology*. 2018
34. Mueller C, Scholer A, Laule-Kilian K, et al. *N Engl J Med*. 2004
35. Estensen ME, Beitnes JO, Grindheim G, et al. *Ultrasound in Obstetrics & Gynecology*. 2013
36. Nishikimi T, Nakagawa Y. *Journal of Cardiology*. 2021.
37. Wang TJ, et al. *Circulation*. 2004
38. Sarma et al. *JACC Advances*. 2022

Basic Views of Cardiac POCUS

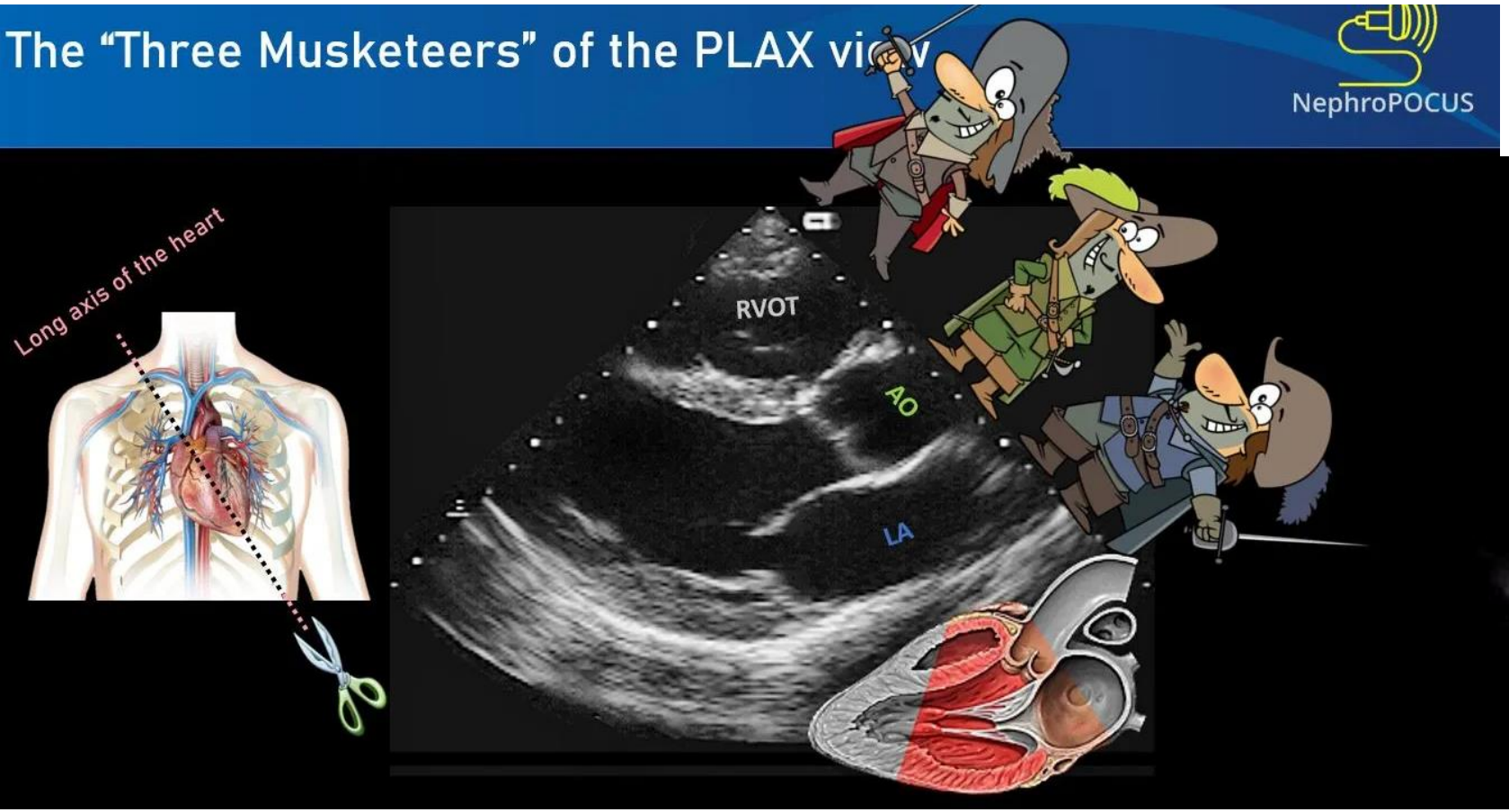


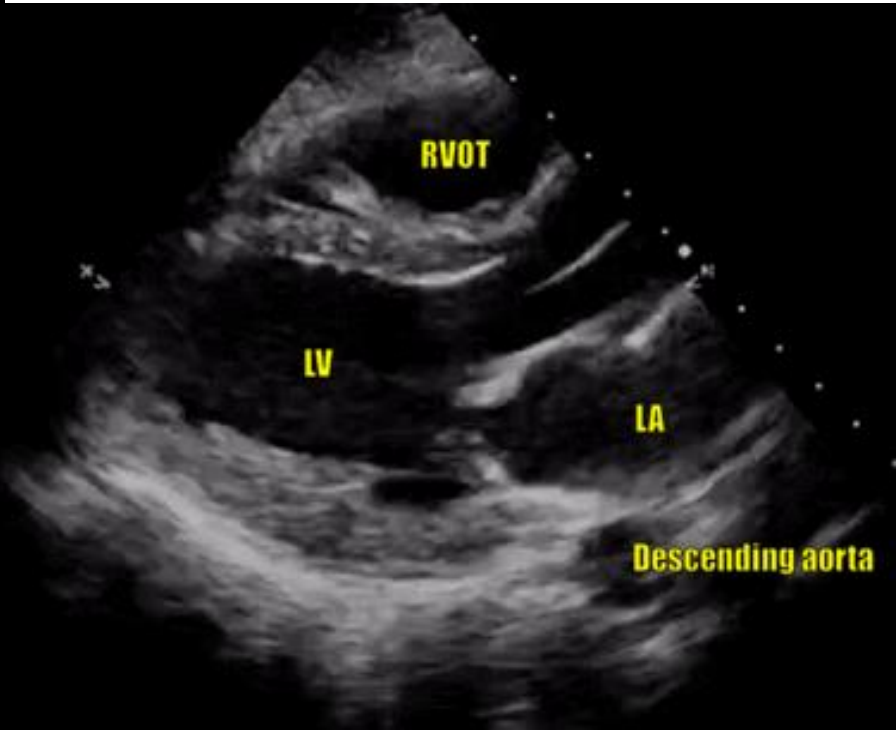
39. Koratala A. Introduction to Focused Cardiac Ultrasound: The Parasternal Long Axis View. Renal Fellow Network. 2019.

Parasternal Long Axis View

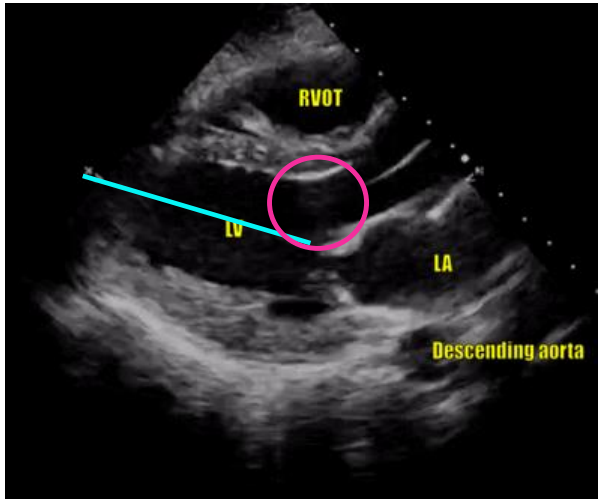
Probe placement:

- **Left of sternum, 3rd of 4th ICS**
- **Indicator points to right shoulder**





39. Koratala A. Introduction to Focused Cardiac Ultrasound: The Parasternal Long Axis View. Renal Fellow Network. 2019
40. Koratala. A. The three musketeers of the parasternal long axis view. NephroPOCUS. 2021

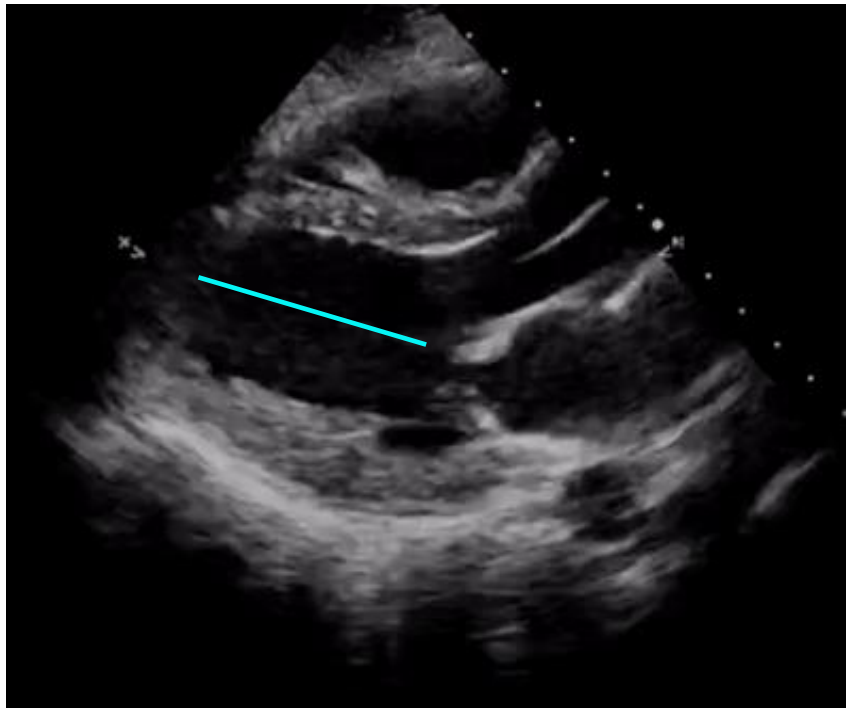


“Eyeballing” the EF in PLAX

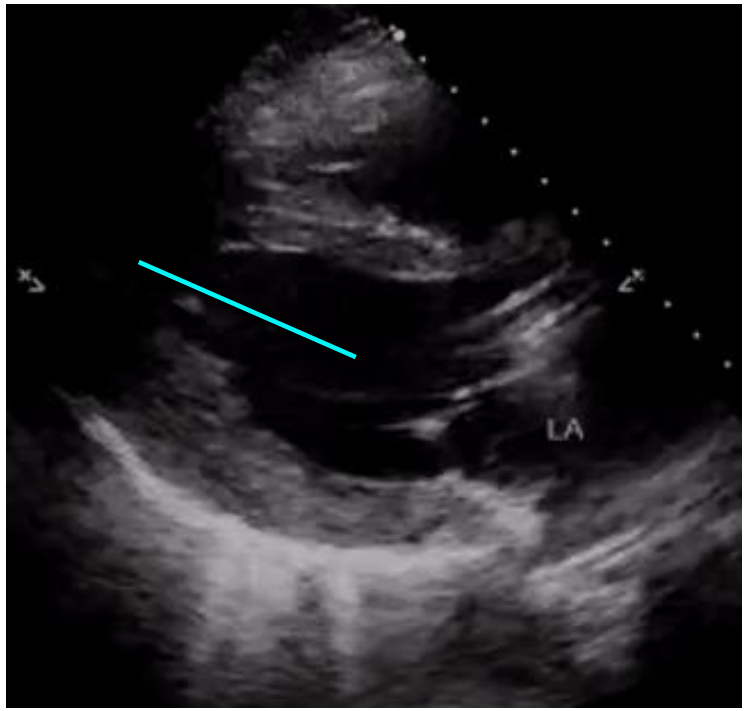
- Are LV walls thickening and moving symmetrically inward during systole ~50 - 60% chamber collapse?
- Is anterior MV leaflet touching the interventricular septum?
    - AR and MS confound MV excursion assessment



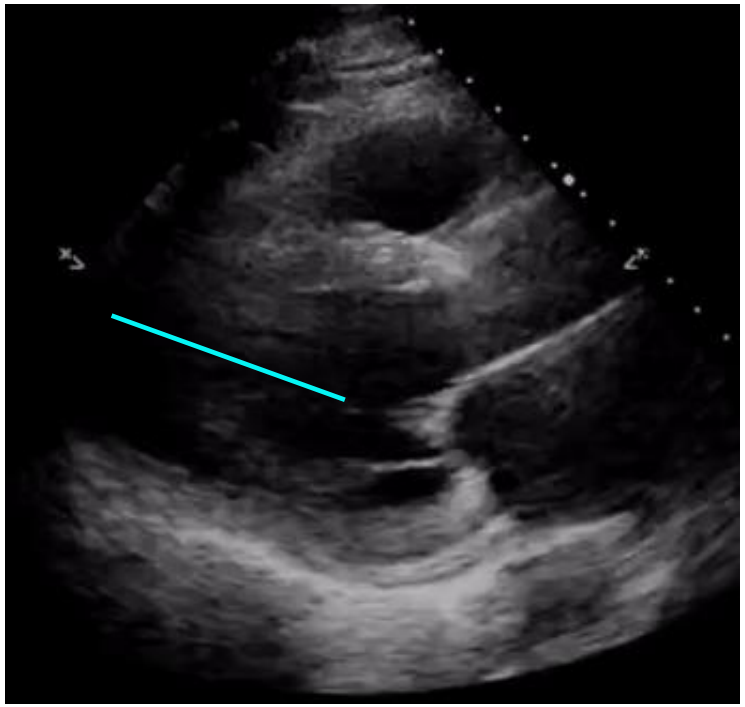
NORMAL
EF > 50%



MODERATELY REDUCED
EF ~ 30-40%

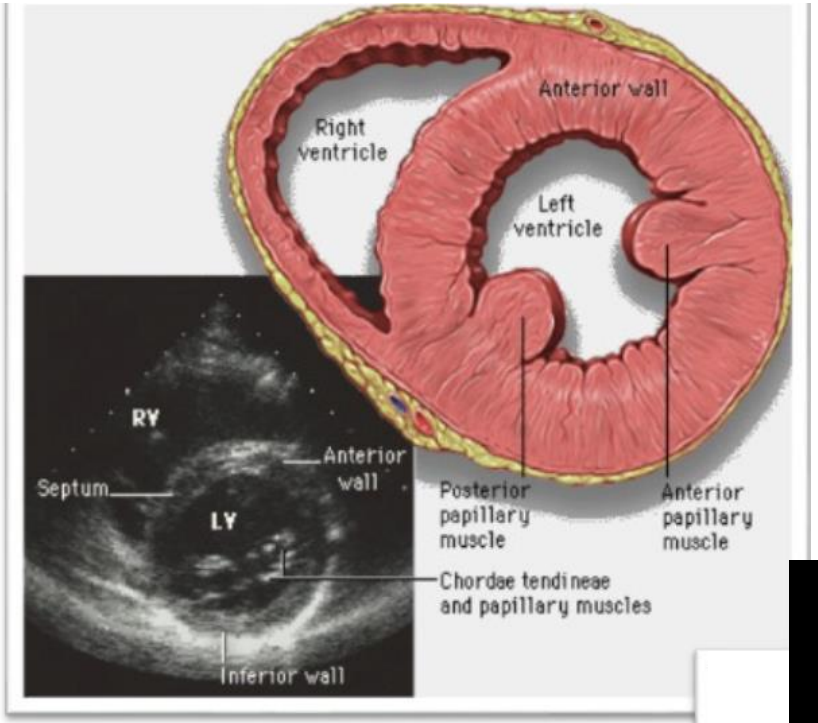


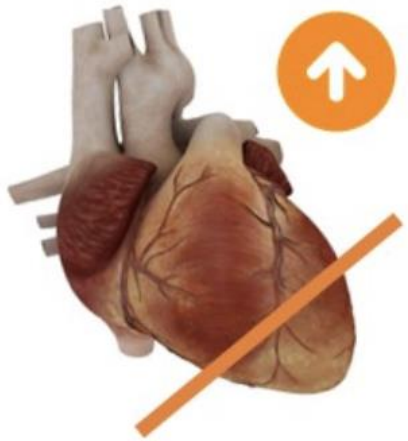
SEVERELY REDUCED
EF < 30%

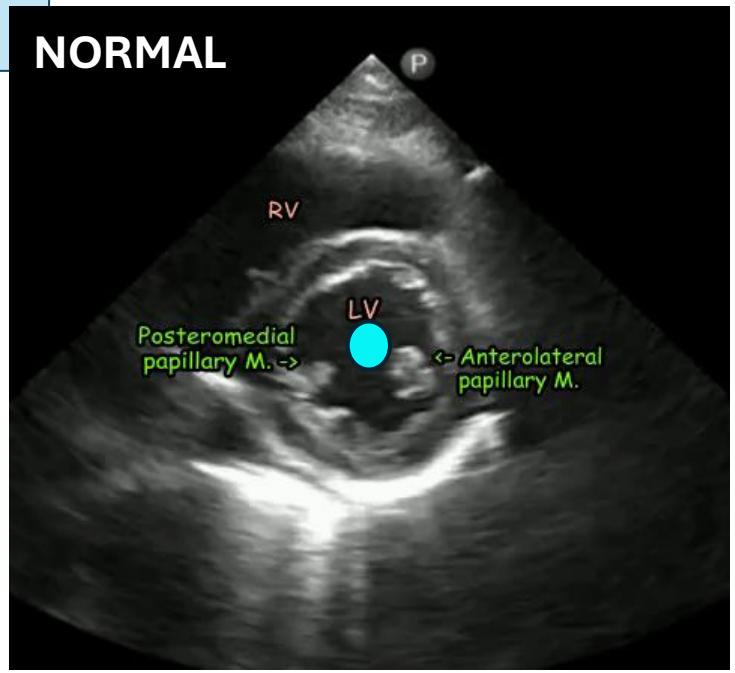


39. Koratala A. Introduction to Focused Cardiac Ultrasound: The Parasternal Long Axis View. Renal Fellow Network. 2019

Parasternal Short Axis View

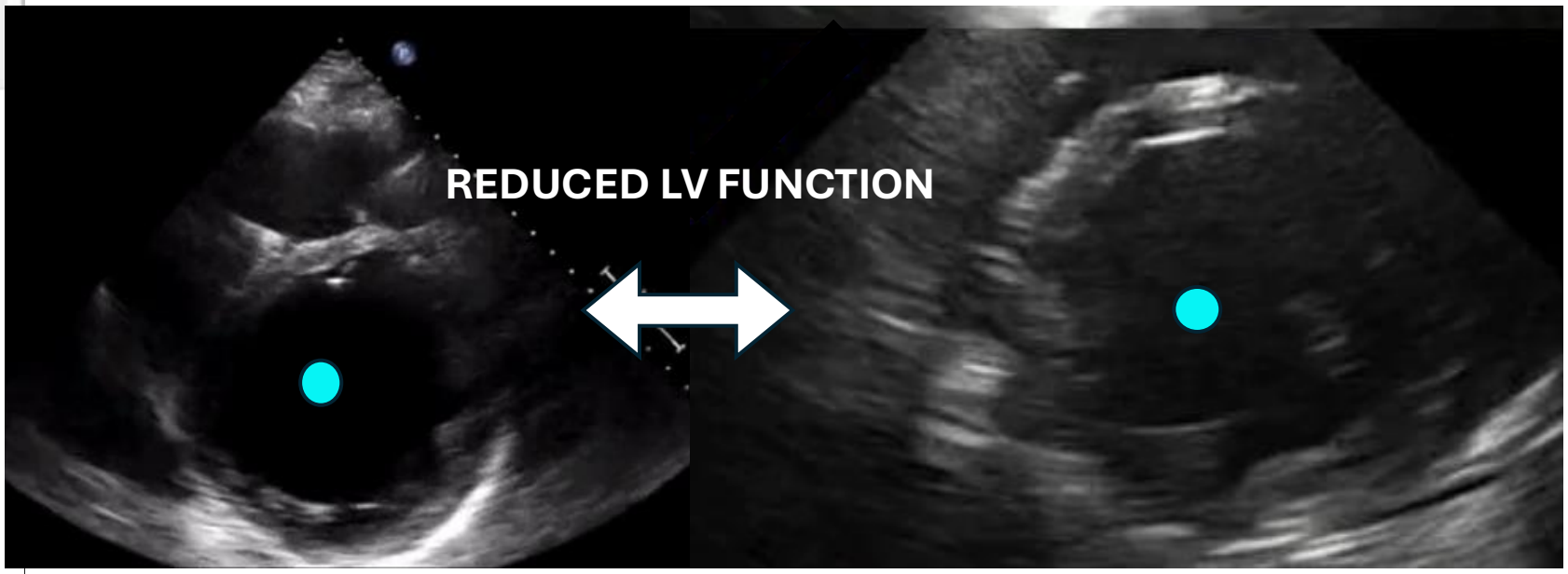






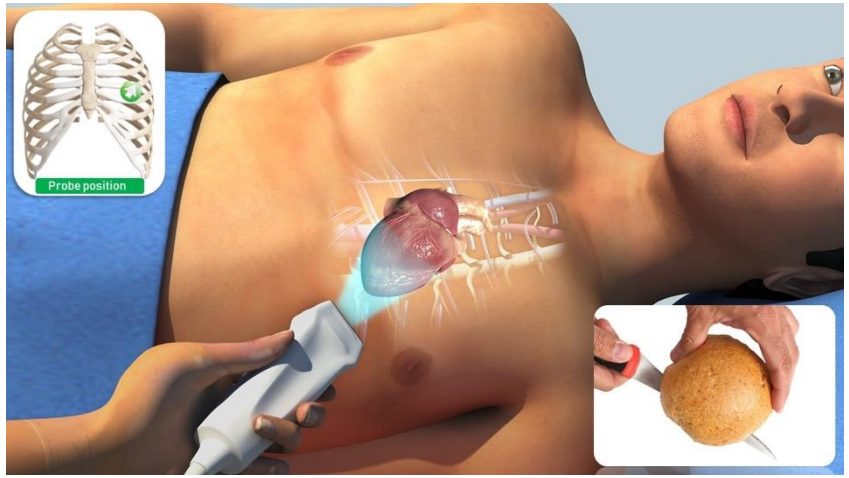
Probe placement:

- **Left parasternal, 4th ICS**
- **Or 90º clockwise turn from PLAX view**
- **Indicator points to left shoulder**
- **Mid-papillary view = mid-ventricle**



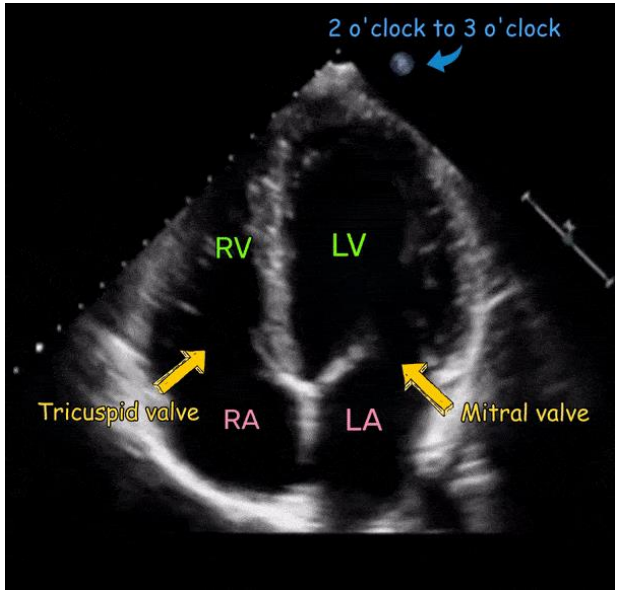
40. Koratala A. Focused Cardiac Ultrasound for the Nephrologist: The Parasternal Short Axis View . Renal Fellow Network. 2019.
41. Kant S, Kant S. Focused Cardiac Ultrasound: Abnormalities on the Parasternal Short Axis View. Renal Fellow Network. 2019

Apical 4-Chamber View



Probe placement:

- **Just below nipple line at PMI**
- **4th-6th ICS MCL**
- **Indicator to left shoulder, probe points through body to right shoulder blade**



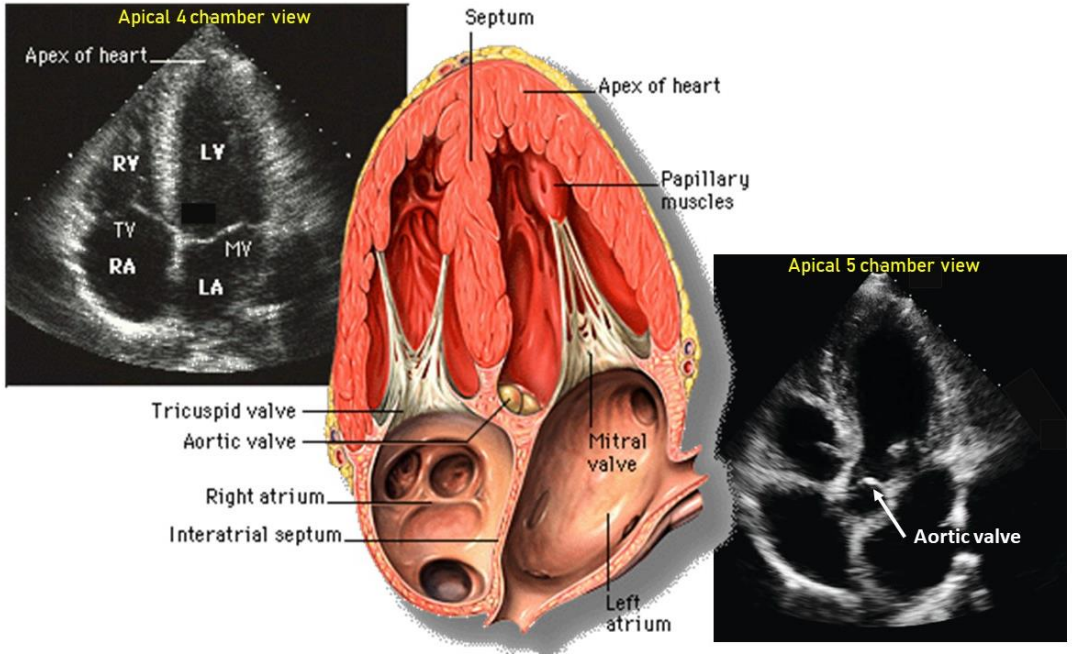
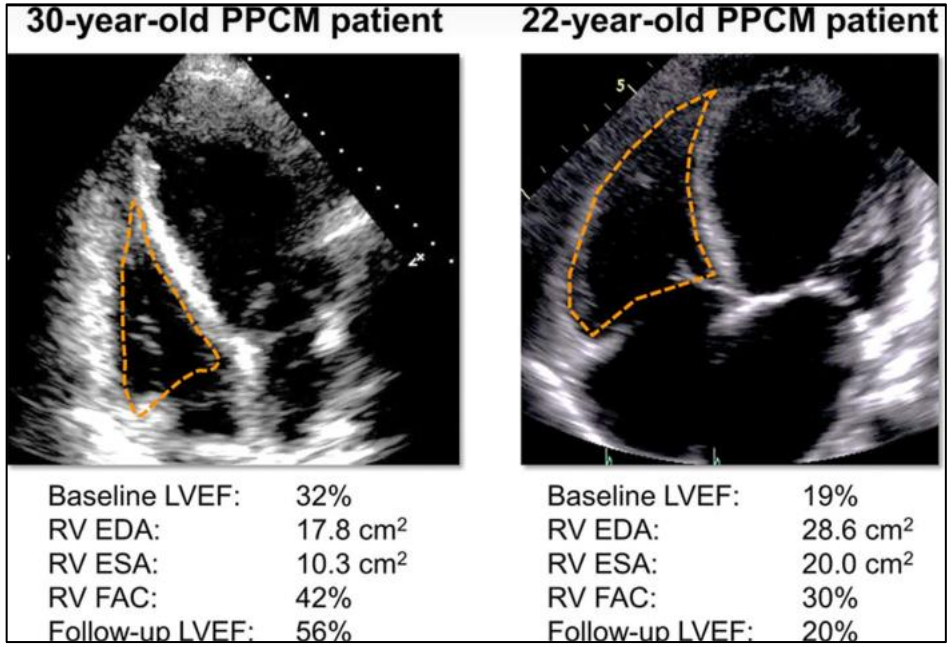


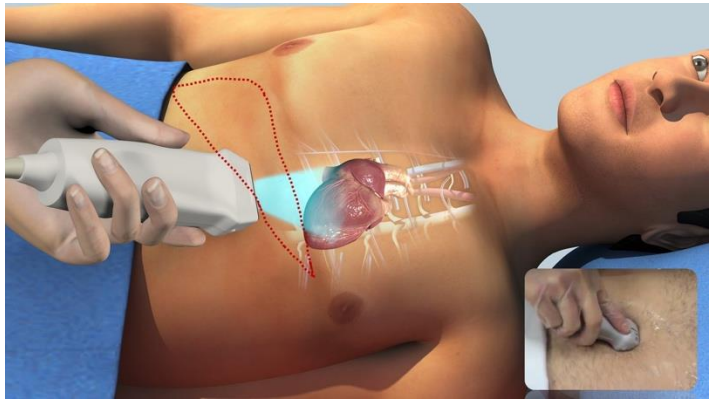
Illustration: Patrick J. Lynch, Wikimedia commons



40. Kant S. Focused Cardiac Ultrasound for the Nephrologist: The apical window. Renal Fellow Network. 2019.

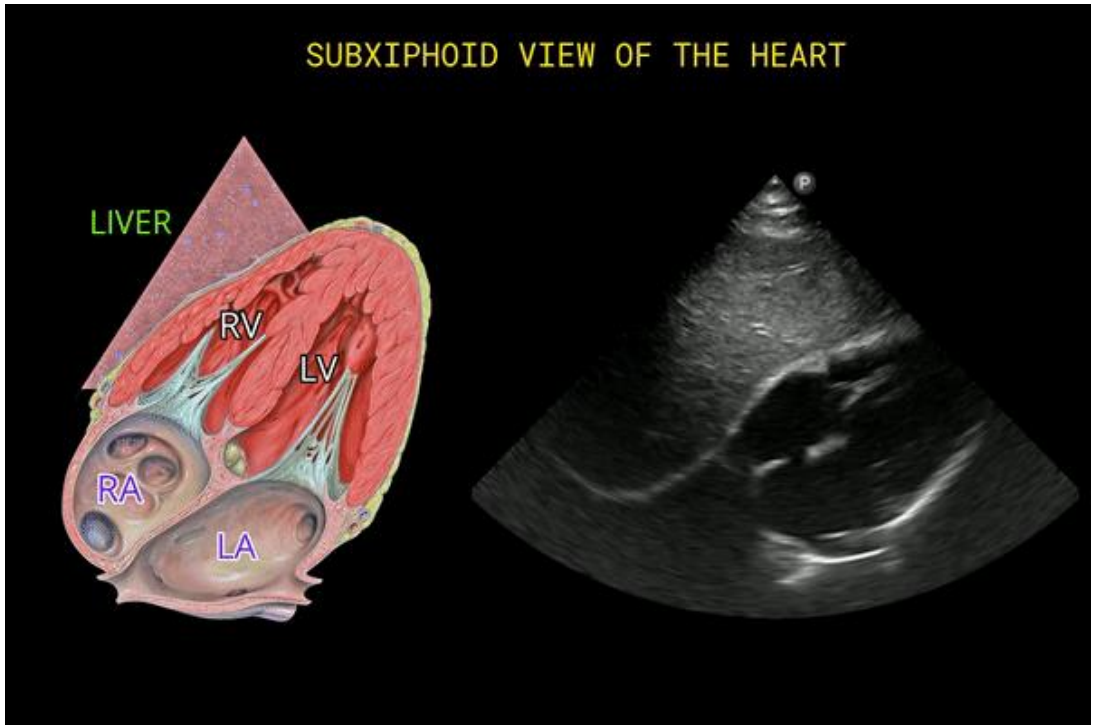
Subxyphoid 4-Chamber View

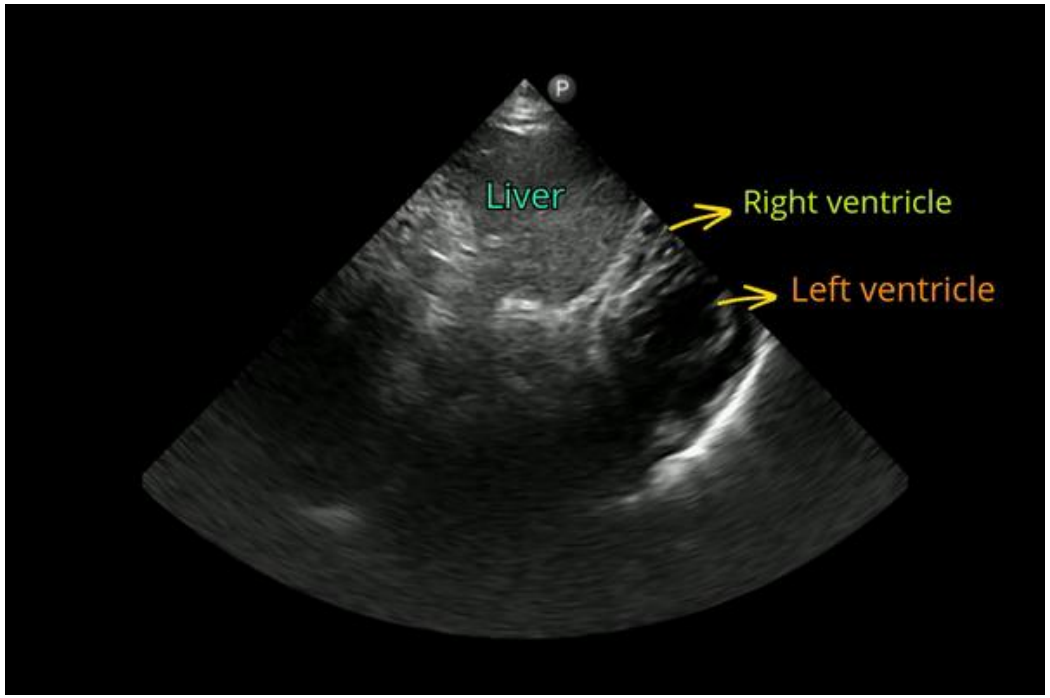
Subxyphoid Short Axis View



Probe position:

- Pt supine, knees bent to relax abdominal muscles
- 2-3 cm below XP & prove face directed upwards into chest, indicator to pt's LEFT (3 o'clock)
- Liver at top of image (looking through liver at heart) w/ right heart close to liver.
- SubX view grossly underestimates overall size (volume) of ventricles
- Can push probe inward slightly and ask pt to take deep breath
- Cardiac phased array probe best. Curvilinear OK but worse view
- Probe rotated 90° counterclockwise for short axis view (indicator to 6 o'clock, and aim probe face towards pt's L shoulder)



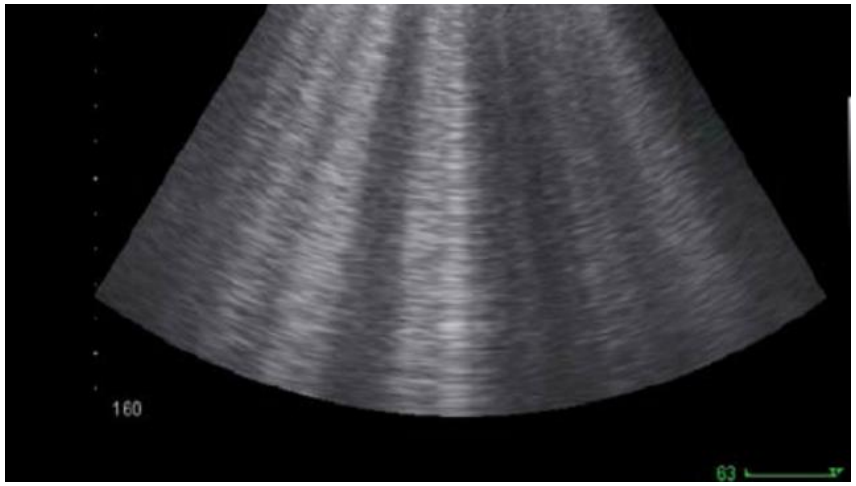


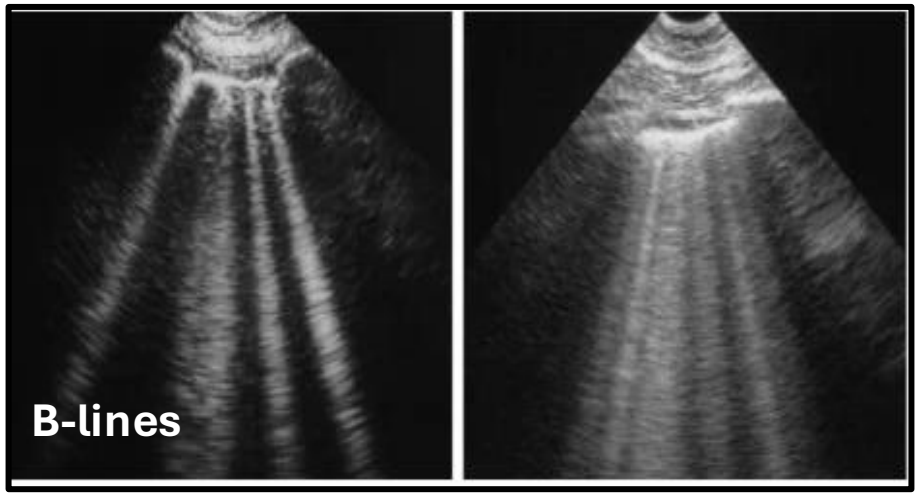
40. Koratala A. Focused Cardiac Ultrasound for the Nephrologist: The Subxiphoid View. Renal Fellow Network. 2020.

SHORTNESS OF BREATH:

ASSESSING FOR

PULMONARY EDEMA





IV Fluids

Acute pulmonary edema is a leading cause of death in women w/ preE[42]

- Aggressive fluid therapy may result in elevation of the PCWP and increased risk of pulmonary edema.
  - Invasive HD monitoring has shown that before IVF, women with PreE have hyperdynamic ventricular function with low PCWP. Aggressive IVF causes PCWP to ↑ significantly above normal with ↑ risk of pulmonary edema[14]
  - 500cc IVF bolus prior to neuraxial may be unnecessary in these pts
  - Once blood loss replaced, preE pts usually have IVF restricted
    - e.g. 1L over 24h - d/c IVF earlier if pt drinking to reduce risk of pulmonary edema.[7]

IMHO for C/S:

- IN LABOR: Run dry - pts been on IVF this whole time. BP tight w/ pressors, wait and assess effect of PP autotransfusion.
- NO LABOR – can give judicious fluids to account for intra-op losses +/- NPO time

42. Hemant B, Mohite KM. *Int J of Clin Obs and Gyn.* 2026
14. Espinoza et al. *ACOG PRACTICE BULLETIN No 222.* 2018
7. Dennis AT, Xin A, Farber MK. *Anesthesiology.* 2025

Pulmonary Edema in Pregnancy

Parturients with heart disease are at high risk of pulmonary edema.

- **Cardiogenic: ventricular dysfunction or failure, or fluid overload (can be iatrogenic)**
- Non-cardiogenic: increased vascular permeability 2/2 damaged endothelium: **SEPSIS**

Heart failure can increase pulmonary capillary hydrostatic pressure

- further increased risk of transudation of fluid into pulmonary interstitium.

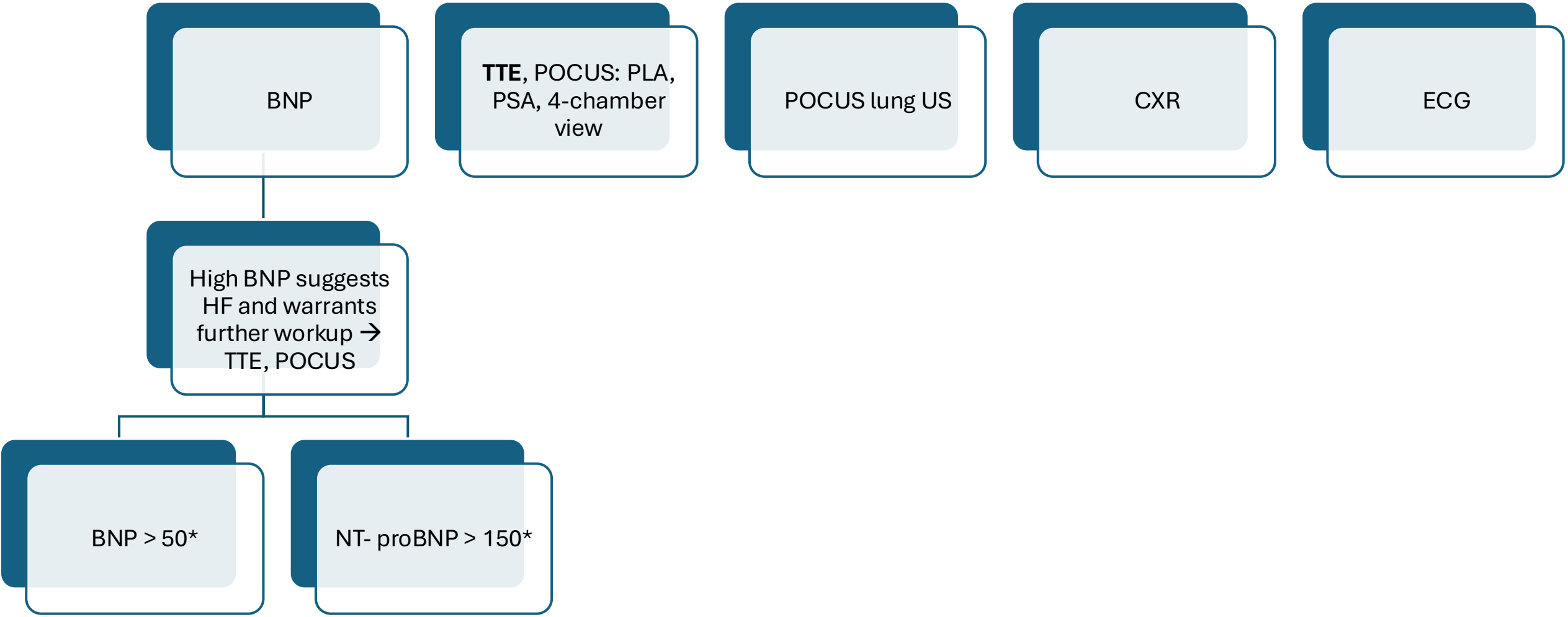
Preparation for potential emergent delivery in acute pulmonary edema 2/2 heart failure includes:

- Rapid management of hypoxemia to prevent maternal or fetal compromise
- **Diuresis, O_2 supplementation** +/- vasodilators & inotropic support, possible tracheal intubation.

21. Meng ML, Arendt KW. *Anesthesiology*. 2021

DIAGNOSTIC TESTS

PULMONARY EDEMA



43. Bauersachs J, König T, Meer P, et al. *European Journal of Heart Failure*. 2019
* 44. Dockrree, et al. *J Endocr Soc*. 2021

Lung Auscultation to Rule Out Pulmonary Edema

UNRELIABLE

This is you



- **LUNGS MAY SOUND NORMAL**
- 2020 observational Simple Intensive Care Studies (SICS -1):
  - **51% of pts (156 of 307) meeting lung US criteria for pulmonary edema had completely normal auscultation** 🌈
  - Agreement btwn auscultation & US was **poor** (κ 0.25) for detecting pulmonary edema
    - Crackles/Crepitus carried a sensitivity of only 66% (specificity 71%)
    - Rhonchi sensitivity 47% (specificity 69%)

45. SICS Study Group, Cox EGM, Koster G, et al. *Critical Care.* 2020

LUNG US vs CXR in Pulmonary Edema

JAMA Network Open

Original Investigation | Emergency Medicine

Diagnostic Accuracy of Point-of-Care Lung Ultrasonography and Chest Radiography in Adults With Symptoms Suggestive of Acute Decompensated Heart Failure
A Systematic Review and Meta-analysis

Anna M. Maw, MD, MS; Ahmed Hassanin, MD; P. Michael Ho, MD, PhD; Matthew D. F. McInnes, MD, PhD; Angela Moss, MS; Elizabeth Juarez-Colunga, PhD; Nilam J. Soni, MD, MS; Marcelo H. Miglioranza, MD, MHSC, PhD; Elke Platz, MD, MS; Kristen DeSanto, MSLS, MS, RD; Anthony P. Sertich, MD; Gerald Salame, MD; Stacie L. Daugherty, MD, MSPH

2019 SRMA: 6 prospective cohort studies, 1827 patients

- Lung US more sensitive than CXR for detection of cardiogenic pulmonary edema, with similar specificity:
  - 15% absolute difference in sensitivity found between LUS and CXR (0.88 vs 0.73) ($P < .001$)
    - In other words: Q 100 patients c/c dyspnea 2/2 cardiogenic pulmonary edema, LUS can dx 15 more cases than CXR without increase in false (+).

- Additional Benefits: LUS easier to see real-time edema resolution, as confirmatory CXR images can lag behind both development and resolution. There is no radiation exposure, and learning curve for use is quick.

46. Maw AM, Hassanin A, Ho PM, et al.. *JAMA network open*. 2019

Comparing Diagnostic Accuracy LUS vs CXR

LUS outperforms CXR sensitivity in detecting certain pulmonary conditions.

Lung/Chest Pathology	Lung US Sensitivity	Chest X-ray Sensitivity
Pneumothorax	92%	52%
Pleural Effusion	93%	65%
Pulmonary Edema	97%	83%

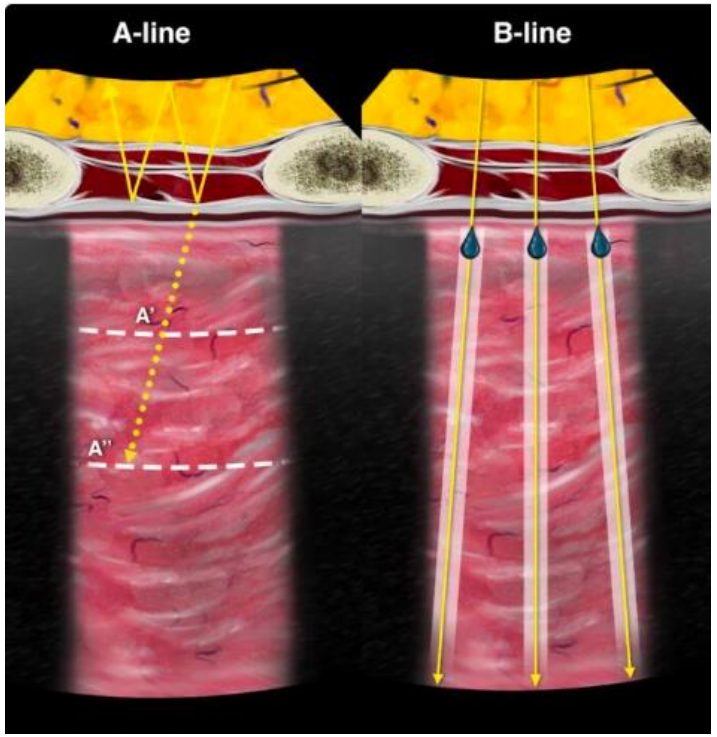
Table 1. Comparison of sensitivity of lung ultrasound versus Chest X-rays in certain lung or chest pathologies.

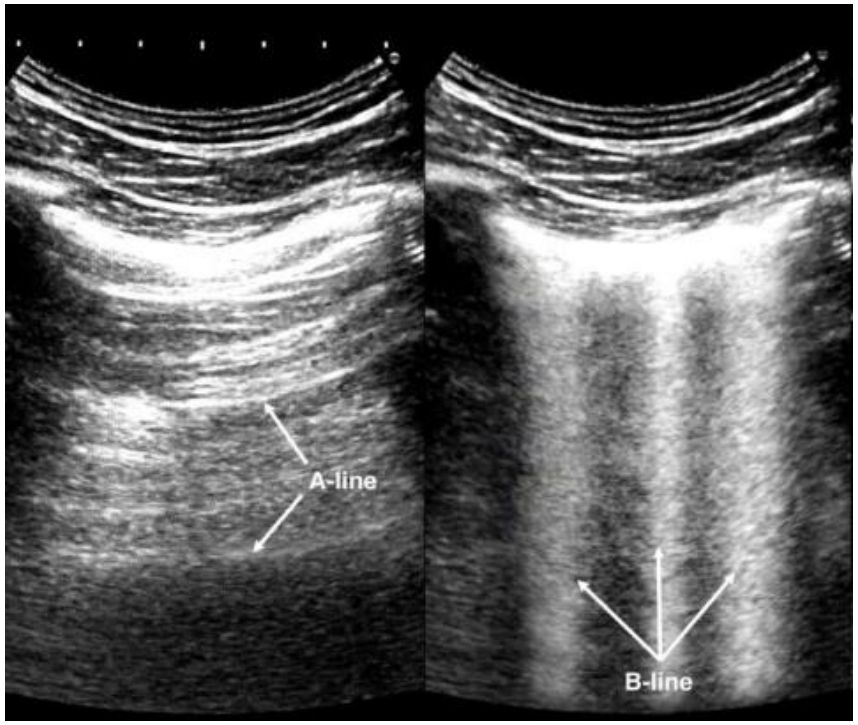
47. Rao V. Point-of-Care Ultrasound Certification Academy. 2026.

POCUS: LUNG ULTRASOUND

A-LINE:
horizontal evenly-spaced hyperechoic reverberation air artifacts of the pleural line.

B-LINE:
well-defined, hyperechoic water artifacts extending from the pleural line down to bottom of screen without fading, obliterating A-lines.[48]

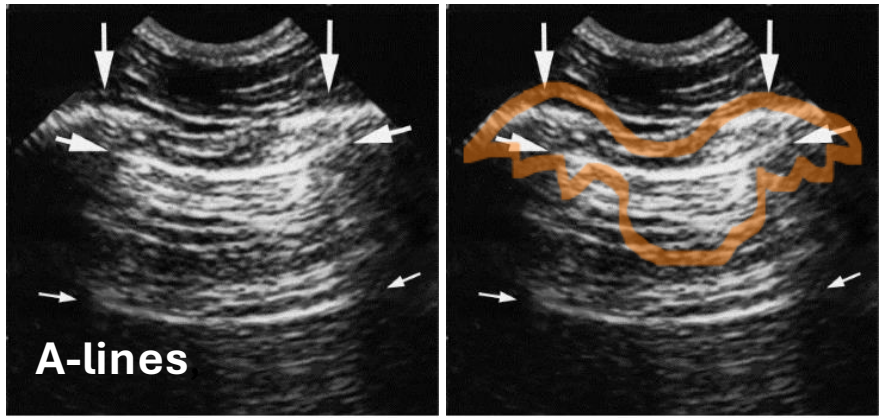


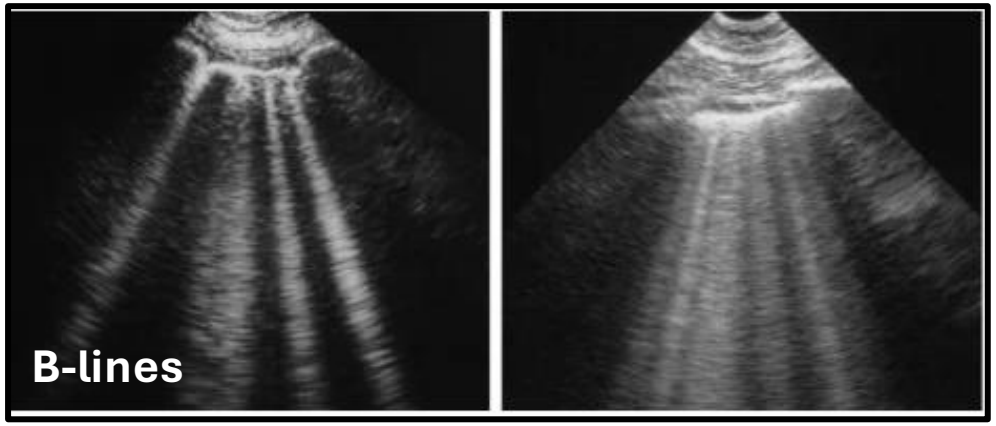


25. NYSORA. Acute respiratory failure: The BLUE protocol. *NYSORA*. 2023.

"bat sign" of rib shadows and pleural line

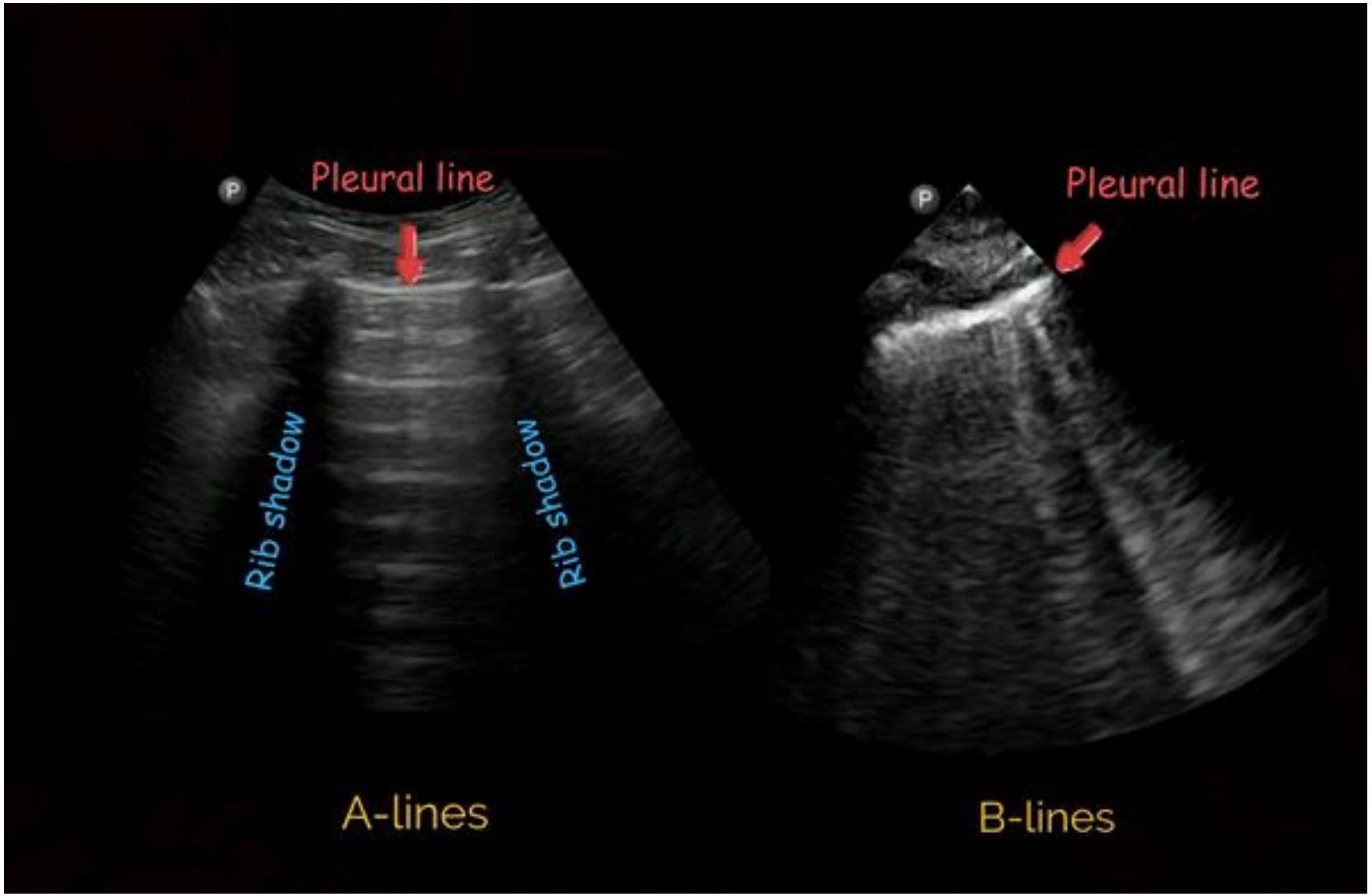






https://annalsofintensivecare.springeropen.com/articles/10.1186/2110-5820-4-1

POCUS: LUNG ULTRASOUND

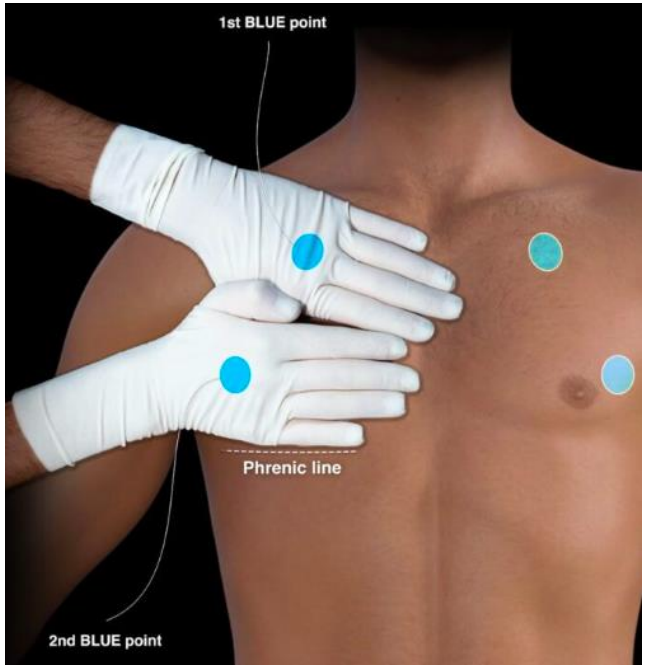


https://www.renalfellow.org/2020/04/08/an-overview-of-lung-ultrasound-for-the-nephrologist-the-covid-19-edition-part-1/

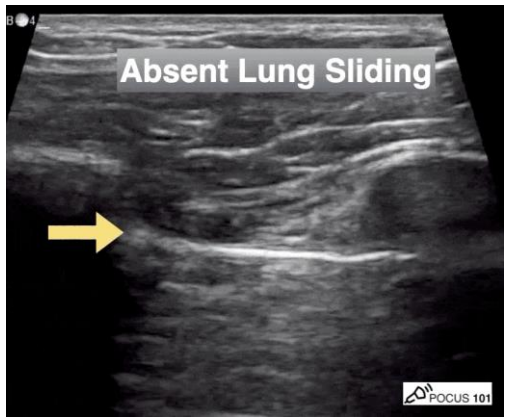
POCUS: LUNG ULTRASOUND

- 3+ B-lines in one field = **"wet" lung.**
  - 1-3 B-lines in bases can be <u>normal finding in pregnancy</u>.

- Visualized lung sliding*, **with**:
  - **3+ B-lines *at all 4 points*** → likely pulmonary edema
    - ➢ lack of lung sliding suggests pneumonia
      - ❖ [**BLUE** protocol – **B**edside **L**ung **U**ltrasound in **E**mergency]



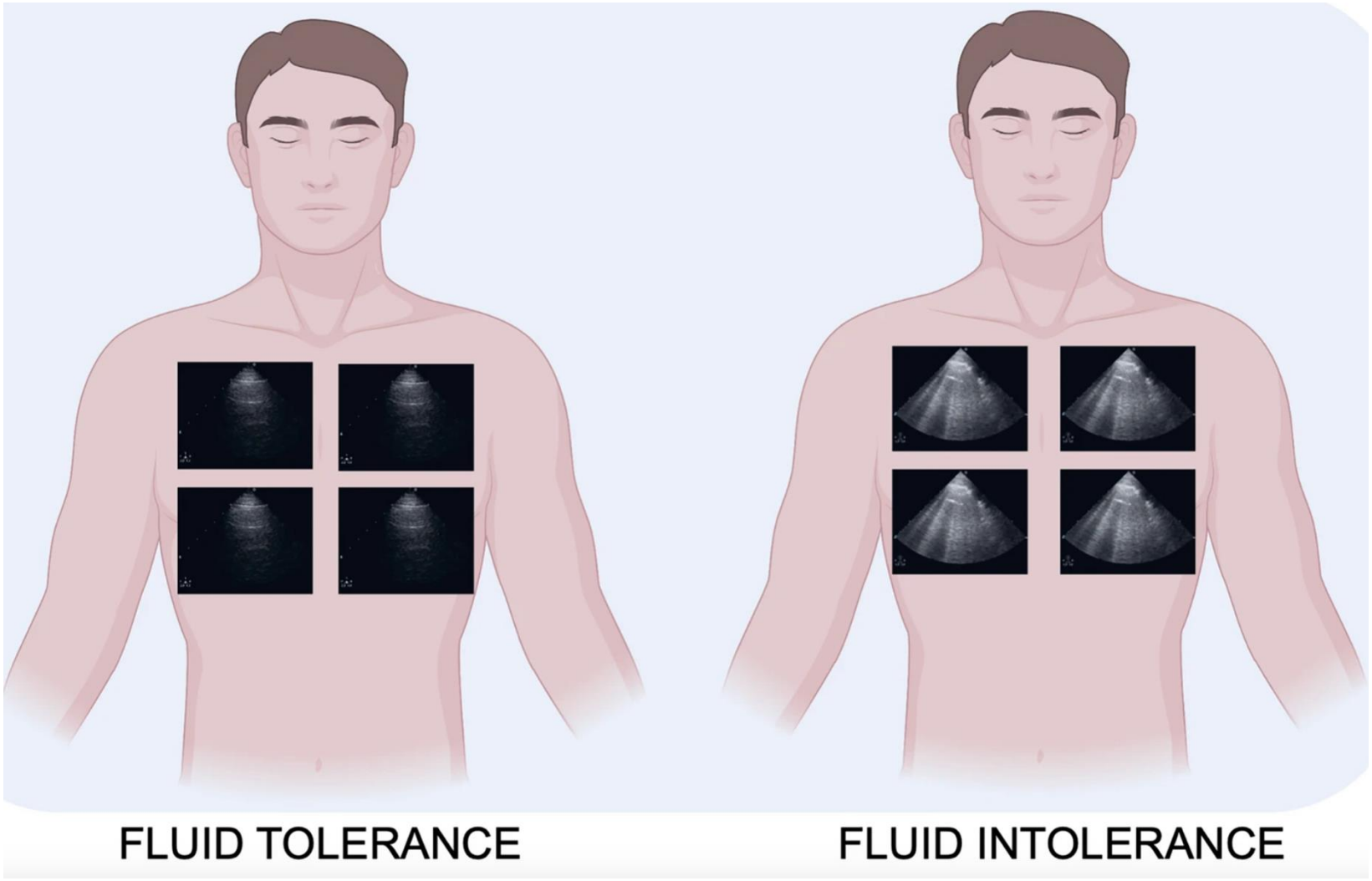




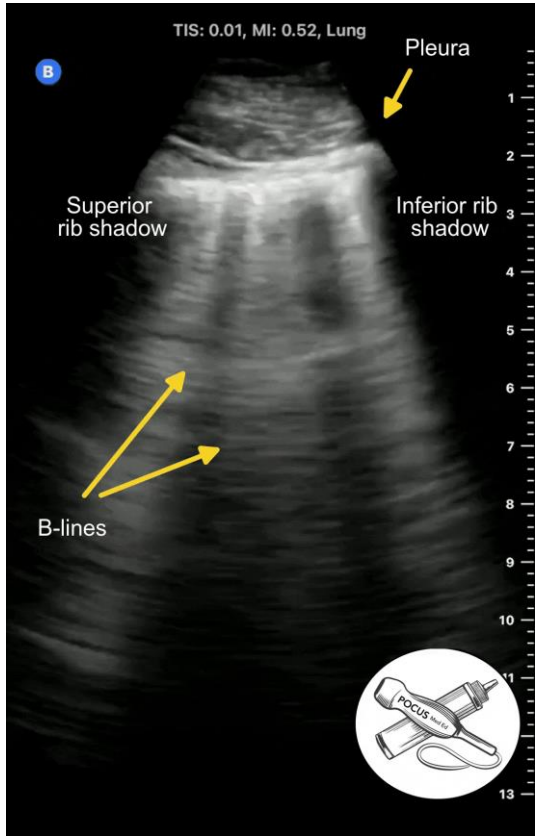
https://www.pocus101.com/efast-ultrasound-exam-made-easy-step-by-step-guide/

48. NYSORA. Acute respiratory failure: The BLUE protocol. *NYSORA*. 2023.

POCUS: LUNG ULTRASOUND



49. Vetrugno L et al. *The Ultrasound Journal*. 2024



https://www.pocusmeded.com/lung

Pulmonary Edema: *Maternal Optimization*

Diuresis

- Careful with high doses in PreE – intravascularly dry patient 2/2 third spacing

Supplemental O2

- HFNC, CPAP, BiPAP: +PEEP

Fluid restriction during delivery (C/S or VD)

- Careful IVF titration
- Smaller reconstitution doses for antibiotics (eg: 20cc syringe slow IVP vs 250cc NS bag for azithromycin)
- **Pitocin**: (instead of 10u over 10min ~ 166cc in 30u/500cc bag)
  - Instead:
    - "Rule of 3s": 10u Pitocin in 10cc NS: Administer 3u Q3min to effect.
    - OBGYN can give IU Pitocin in C/S in lieu of IV bolus - (IM pit may have better HD stability, but may be less effective)[52,53]

50. Oladapo OT et al. *Cochrane Database of Systematic Reviews*. 2020
51. Naruse et al. *Nature: Scientific Reports*. 2026

Pulmonary Edema in **PREECLAMPSIA**

- When **HTN** *causes* ***pulmonary edema*****, IV NTG** is preferred[18]
  - vs standard 1st line anti-HTN agents: IV Labetalol, hydralazine, or oral nifedipine

- Titrated NTG can offload ventricles without affecting contractility
  - *Especially in LV systolic dysfunction/PPCM*:
    - ➢ Added inotropes (eg: dobutamine) can augment contractility without increasing SVR to improve forward flow
      - ➢ Initiation of high-dose BBs may be detrimental in poor LV contractile function and HR-dependent CO

  - NTG gtt offers tight HD control with rapid onset and short $Et^{1}/_{2}$
    - **DOSE: 5 mcg/min, titrate Q 3–5 min to max dose 100 mcg/min.**[18]

IMPORTANCE OF BNP → +/- TTE to assess which agents would be most beneficial if myocardial dysfunction present.

52. Regitz-Zagrosek V, Roos-Hesselink JW, Bauersachs J, et al. *European Heart Journal.* 2018.

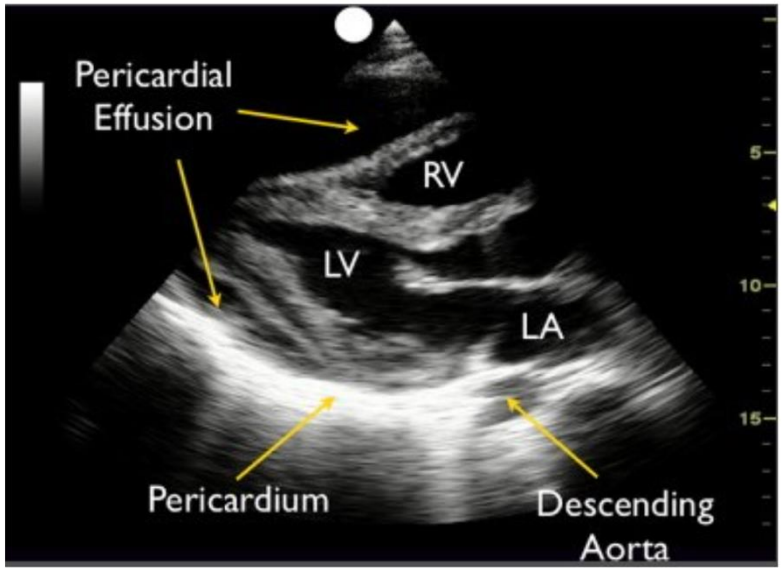
SHORTNESS OF BREATH:

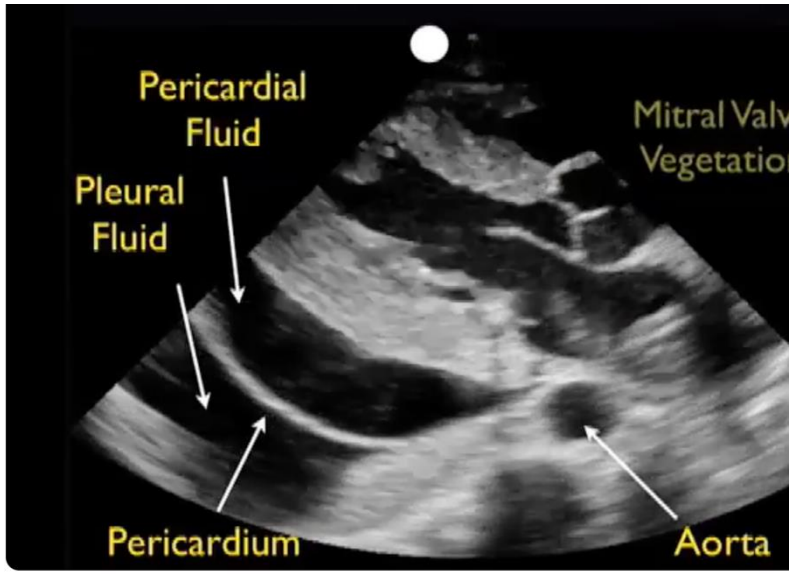
ASSESSING FOR

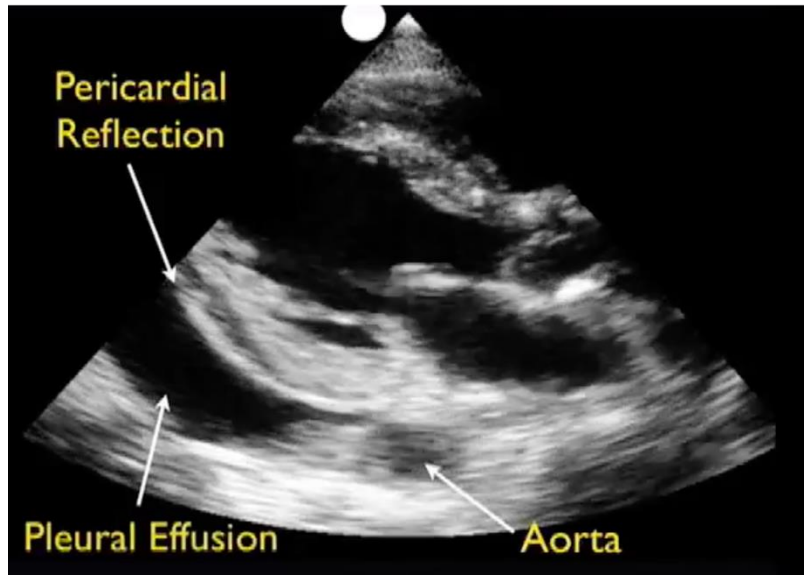
PLEURAL EFFUSION

Assessment in PLAX view

PLEURAL vs PERICARDIAL Effusion







https://www.youtube.com/watch?v=ZKueDyf27gM&t=19s

Pleural Effusion Assessment in PLAX view

NORMAL

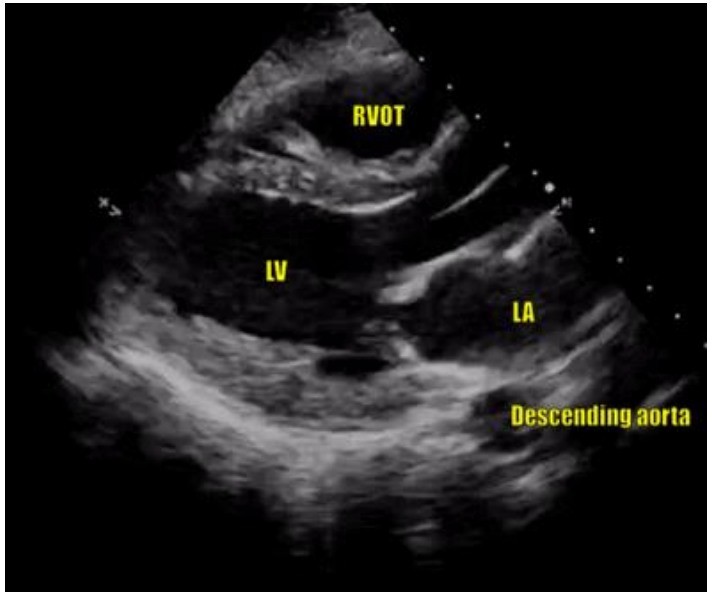
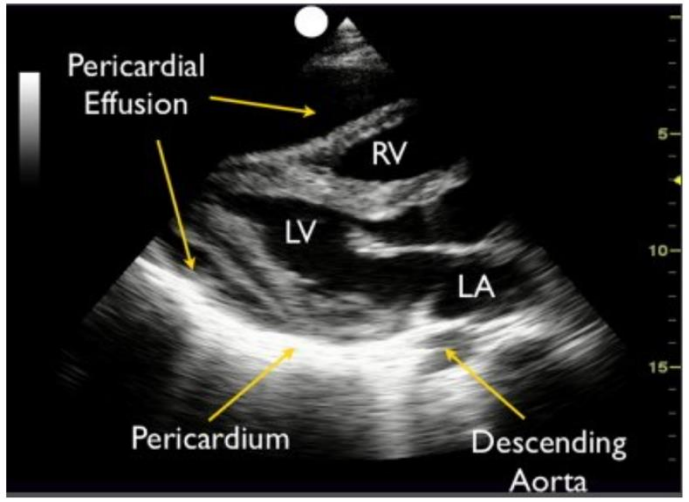
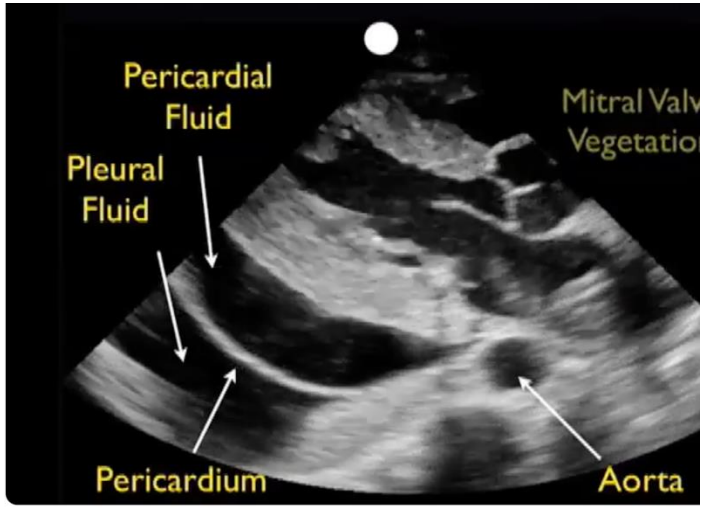
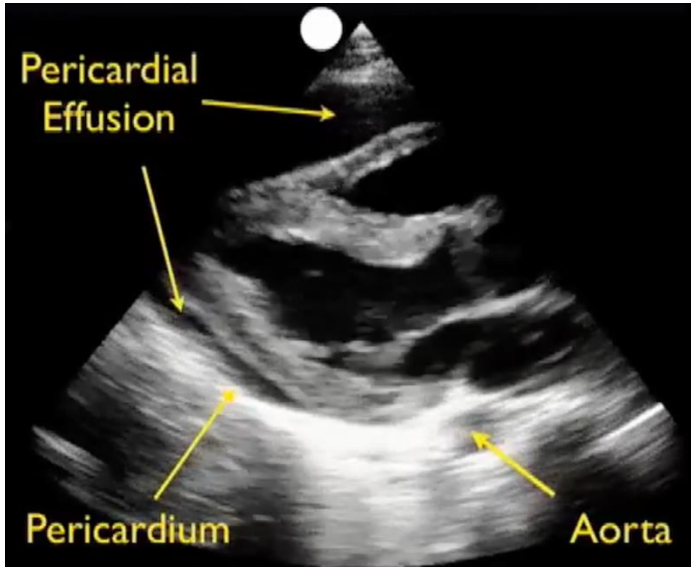


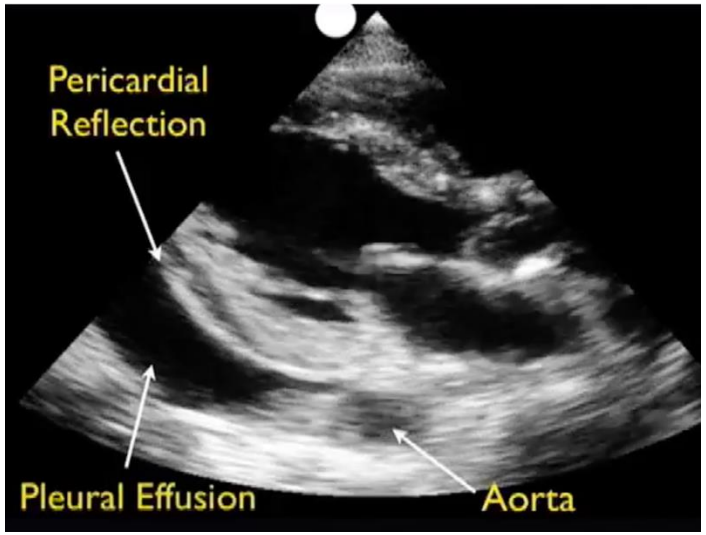
Figure 6. Normal PLAX view
https://www.renalfellow.org/2019/06/07/introduction-to-focused-cardiac-ultrasound-the-parasternal-long-axis-view/

Differentiating **PERICARDIAL** vs **PLEURAL** Effusion



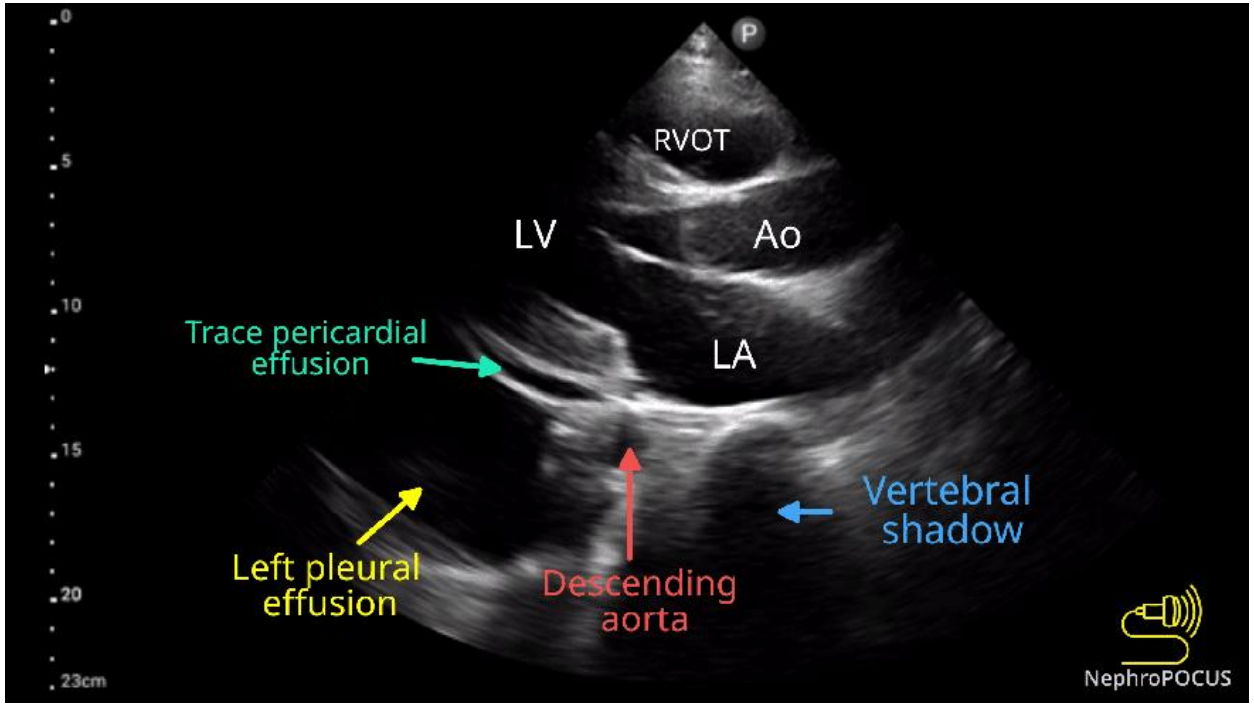


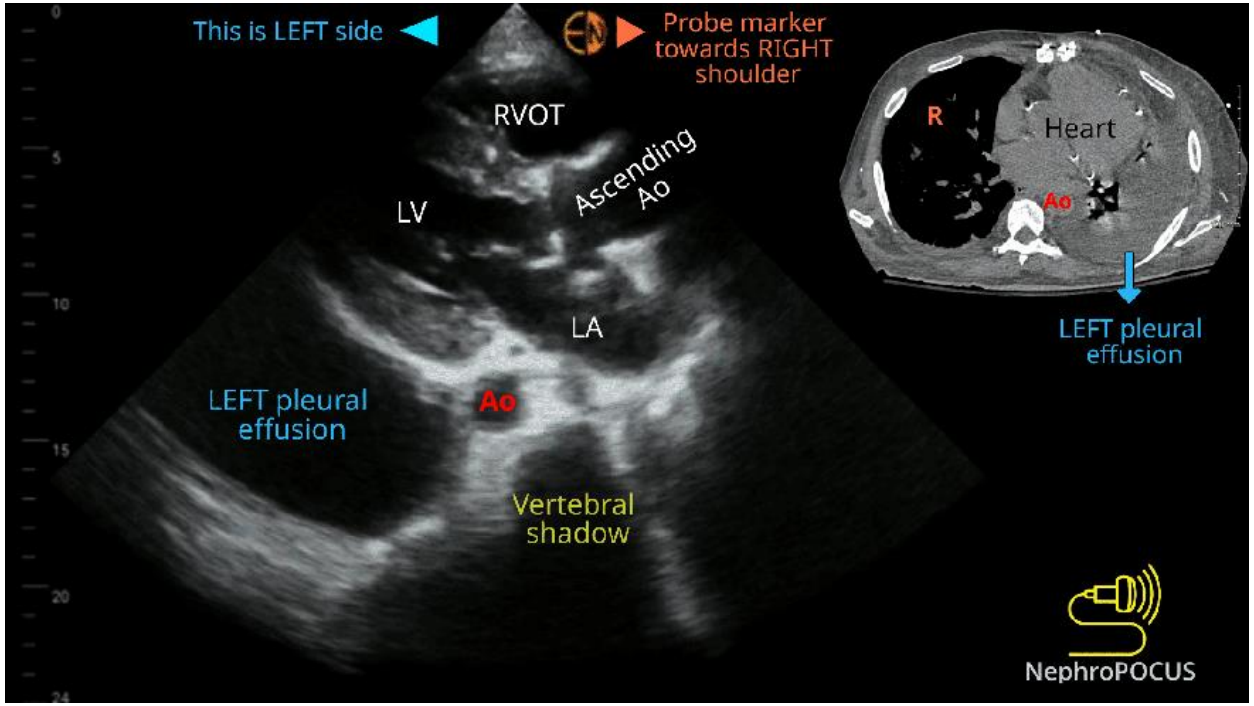




Cardiac Ultrasound - Parasternal Long Axis - Part 2 - SonoSite, Inc.
https://www.youtube.com/watch?v=ZKueDyf27gM&t=19s

Pleural Effusion Assessment in PLAX view



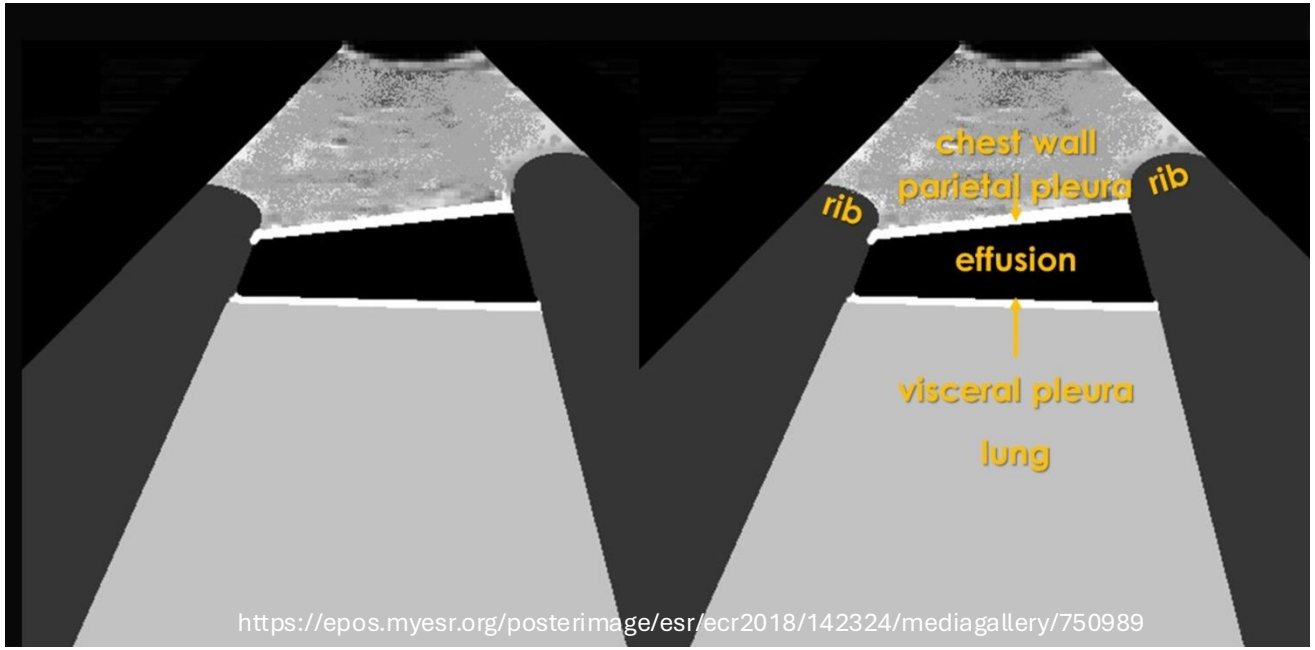


https://nephropocus.com/2019/12/07/pericardial-versus-pleural-effusion-on-plax-view/#jp-carousel-55588

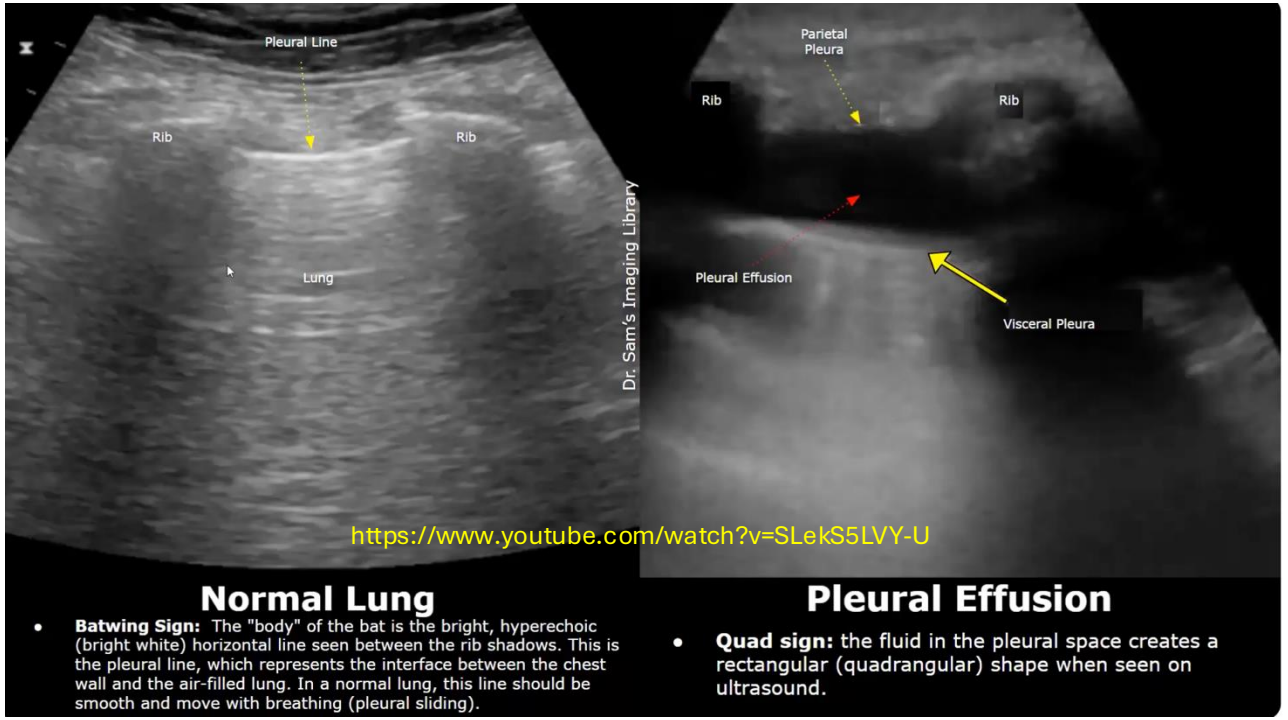
Lung Field US : Quad Sign

- Parietal & Visceral pleura
- Anechoic rectangular “quad” effusion space
- Rib shadowing on either side

- Absent lung sliding
- B-lines may be present as well.



https://epos.myesr.org/posterimage/esr/ecr2018/142324/mediagallery/750989



https://www.youtube.com/watch?v=SLekS5LVY-U





Roses are Red



Violets are Blue



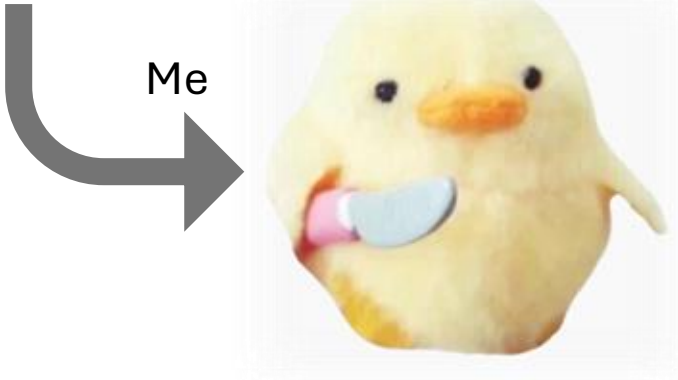
If she’s short of breath

Put a f*ing probe on her chest



Or I’ll have to kill you.





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