Preeclampsia & HELLP

December 11, 2016 by Josh Farkas

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presentation & diagnosis

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when to suspect pre-eclampsia?

- Very common among critically ill pregnant women.
  - Consider any pregnant woman admitted to ICU as having preeclampsia until proven otherwise.
- Usually occurs between 20 weeks of gestation and about 6 weeks postpartum.
  - Rarely can occur earlier than 20 weeks in patients with molar pregnancies.
- Main clue is hypertension, but patients aren't always profoundly hypertensive.
- Common risk factors for preeclampsia:
  - Age >35
  - Obesity, obstructive sleep apnea
  - History of preeclampsia, renal disease, hypertension, or diabetes
  - Thrombophilia, lupus, antiphospholipid antibody syndrome

clinical findings of preeclampsia

- Cardiopulmonary
  - Hypertension
  - Pulmonary edema
  - Pitting edema – especially involving hands and face (non-dependent edema, suggesting endothelial dysfunction)
- Renal: acute kidney injury, oliguria
- GI: epigastric or right upper-quadrant discomfort
- Neurologic
  - Hypertensive encephalopathy with vision changes & headache
  - Intracranial hemorrhage
  - Hyper-reflexia (sometimes with clonus), seizures

lab panel for pregnant ICU admission

- Electrolytes including Ca/Mg/Phos
- Complete blood count
- Liver function tests & ammonia
- Coags, D-dimer, and fibrinogen (note that normally, fibrinogen is elevated in pregnancy).
- LDH and haptoglobin
- Urinalysis and spot urine protein/creatinine ratio
- If febrile/hypotensive: lactate, blood cultures, procalcitonin
definition of preeclampsia?

- [1] HTN developing or worsening >20 weeks after gestation:
  - SBP >160 or DBP >110 (persistent over >15 minutes)
  - or-
  - SBP >140 or DBP >90 (persistent over >4 hours)
- [2] Plus ANY of the following (proteinuria isn't required for the diagnosis)
  - Proteinuria >0.3 g/d
    - Reasonable surrogate measure is a spot urine protein/creatinine ratio >0.3 mg/mg.
    - Urine dipstick showing proteinuria is nonspecific, but a negative dipstick can usually be accepted as excluding significant proteinuria.
  - Acute kidney injury (Cr > 1.1 mg/dL or doubling of baseline value; note that normally Cr <0.8 mg/dL in pregnancy)
  - Cerebral or visual disturbance (including severe headache, seizure, delirium, clonus)
    - Note that the presence of seizures technically defines this as "eclampsia" (rather than preeclampsia).
  - Pulmonary edema
  - Transaminases above twice normal
  - Platelets <100,000/mm3
- [3] Exclusion of alternative diagnoses, for example:
  - Alternative cause of renal failure (e.g. glomerulonephritis)
  - Alternative cause of hypertensive emergency (e.g. thyroid storm, cocaine)
  - Primary CNS disease (e.g. meningitis, CVA)
  - EtOH withdrawal
  - Other types of microangiopathic hemolytic anemia (e.g., thrombotic thrombocytopenic purpura, hemolytic uremic syndrome)

diagnosis of HELLP syndrome (Hemolysis, Elevated LFTs, Low Platelets)

- HELLP is a manifestation of pre-eclampsia (not a separate disorder). It's a thrombotic microangiopathy which may be closely related to atypical hemolytic uremic syndrome.
- Clinical symptoms may include nausea/vomiting and right upper-quadrant pain.
- Laboratory findings:
  - Microangiopathic hemolytic anemia (e.g. high LDH, low haptoglobin, schistocytes on blood smear)
  - Elevated AST and ALT (above twice the upper limit of normal).
  - Platelets <100,000/mm3.
  - May cause hepatic hematoma that ruptures, leading to hemoperitoneum.
- Differential diagnosis includes pregnancy-induced thrombotic thrombocytopenic purpura (TTP) and acute fatty liver of pregnancy.
- Treatment of HELLP is discussed [below](#treatment_of_HELLPSyndrome).

HTN & volume management

blood pressure targets

- General strategy
  - Antihypertensives generally indicated if SBP>160 or DBP>105 (MAP >120).
  - Initial goal is decreasing MAP by ~20%.
  - Eventually, the blood pressure should be gradually decreased to a target MAP of roughly ~100-115 mm. This target should be individualized to a certain extent, depending on the baseline blood pressure.
- Balance is required:
  - Lowering blood pressure prevents end-organ hypertensive damage (e.g., intracranial hemorrhage).
  - Excessive blood pressure drop may cause hypoperfusion (including the placenta). Placental hypoperfusion may stimulate the release of vasoconstrictive/inflammatory factors, which aggravate the underlying disease process.
### Initial Antihypertensive Agents for Preeclampsia

<table>
<thead>
<tr>
<th>Agent</th>
<th>Pro</th>
<th>Con</th>
<th>Contraindications, Cautions</th>
<th>Onset &amp; duration</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV Nicardipine</td>
<td>- Effective, more easily titrated than labetalol</td>
<td>- Cough (pseudoephedrine)</td>
<td>- Nifedipine (caused by liver)</td>
<td>Onset: 15 min.</td>
<td>- 2.5-15 mg/hr</td>
</tr>
<tr>
<td></td>
<td>- Highly vasoactive, but historically used less frequently than labetalol</td>
<td></td>
<td></td>
<td>Lasts: 1-3 hours.</td>
<td></td>
</tr>
<tr>
<td>IV Labetalol</td>
<td>- Traditional agent of choice</td>
<td>- Can cause bradycardia</td>
<td>- Nifedipine (caused by liver)</td>
<td>Onset: 5-15 min.</td>
<td>- Load with sequential pulses of 20 mg, 40 mg, 80 mg, 160 mg (4x15 min IV). In patients not requiring rapid blood pressure control, may be most sensible to administer as sequential boluses to keep in range.</td>
</tr>
<tr>
<td></td>
<td>- Can cause thryotoxic.</td>
<td>- Bradycardia</td>
<td></td>
<td>Lasts: 3-6 hours.</td>
<td></td>
</tr>
<tr>
<td>IV Nitroglycerine</td>
<td>- Useful in patients with volume overload, cardiogenic pulmonary edema, or intermittent myocardial ischemia</td>
<td>- Headache</td>
<td>- Phosphodiester inhibitors use (e.g., sodium) 48 hours</td>
<td>Onset: 2 minutes.</td>
<td>- 0-300 mcg/min</td>
</tr>
<tr>
<td></td>
<td>- Reduced intracranial pressure</td>
<td></td>
<td></td>
<td>Lasts: 10 min.</td>
<td></td>
</tr>
<tr>
<td>IV Hydralazine*</td>
<td>- Unpredictable efficacy; may cause overshoot hypotension</td>
<td>- May cause overshoot hypotension (associated with more intensified titration)</td>
<td>- Headache, tachycardia</td>
<td>Onset: 20 minutes.</td>
<td>- Start with 5 mg IV. Then additional 5-10 mg doses as needed every 20-40 minutes (to a maximal dose of ~20 mg total used daily).</td>
</tr>
<tr>
<td>Oral Nifedipine</td>
<td>- May be useful in situations with limited IV access.</td>
<td>- May cause overshoot hypotension</td>
<td>- Headache, tachycardia</td>
<td>Onset: 20 minutes.</td>
<td>- 10 mg PO, repeat every 30-60 minutes as needed (no more than 50 mg total used initially).</td>
</tr>
<tr>
<td>(Immediate release)*</td>
<td></td>
<td></td>
<td></td>
<td>Lasts: 6 hours.</td>
<td></td>
</tr>
</tbody>
</table>

*Not generally preferred as front-line agents; may be used if other agents are unavailable or ineffective.

[https://emcrit.org/ibcc/preeclampsia/](https://emcrit.org/ibcc/preeclampsia/)

### Initial Antihypertensive for Rapid Blood Pressure Control

- **Nicardipine infusion**
  - Not traditionally a first-line agent for preeclampsia.
  - However, it is an accepted option which has been shown to be safe and effective. It may be the most easily titrated strategy.

- **Labetalol**
  - Traditionally the first-line agent.
  - Given long half-life of labetalol, may be most sensible to administer as sequential boluses (see below).

- **Nitroglycerine infusion**
  - May be useful in patients with cardiogenic pulmonary edema.

- **IV Hydralazine**
  - Not usually preferred, due to the capacity to cause unpredictable and prolonged drops in blood pressure.
  - If hydralazine is used, caution should be employed (e.g. using small doses, provided gradually over time).

- **Oral Nifedipine Immediate Release**
  - Although traditionally avoided in hypertensive emergencies, recent studies have shown that oral nifedipine is a potential treatment of preeclampsia.
  - If nifedipine is used, safety may be improved by spacing out doses sufficiently. Also note that the tablet must be swallowed whole (not administered sublingual or chewed or broken open).
fluid resuscitation

- Pre-eclampsia causes endothelial damage, leading to third-spacing of fluids. This creates a very challenging situation, where patients are often intravascularly depleted. Unfortunately, administered fluid will generally rapidly extravasate into the tissues (causing harm rather than benefit).
- Some fluid might be reasonable to support perfusion among patients who are NPO (e.g. ~50 ml/hr of 5% dextrose in half-normal saline). However, large volumes should be avoided, as this may promote pulmonary edema.
  - Avoid chasing oliguria with large volume of fluid. If oliguria doesn't respond to a small fluid bolus (300 ml), additional fluid may be inadvisable.⁸

Kat Evans at #SMACC discussed women presenting with eclampsia/preeclampsia in an emergency setting do not need IV crystalloids. Receiving enough with IV meds. High risk of fluid overload and Pulmonary Oedema. #INFiLL

See Bel Bruce's other Tweets
Infuse magnesium at 1-2 grams/hour (4-8 mM/hour) (some newer data and guidelines suggest that 1 gram/hour may be adequate).

Load with 6 grams IV magnesium sulfate (24 mM).

The optimal duration of the magnesium infusion is unclear. Treatment is often continued until ~24 hours after delivery, when the patient is stable.

Other options which are safe for pregnancy include hydralazine, prazosin, or clonidine.

Start oral antihypertensives once hemodynamically stabilized and improving. Unfortunately, many antihypertensives aren't suitable for pregnancy.

Labetalol is generally the first-line agent (especially for patients who responded to IV labetalol).

- Start 200 mg PO BID
- Escalate dose gradually, until no longer requiring IV labetalol doses.

Extended-release nifedipine is another solid option.

Methyldopa is traditionally used; it is safe but not terribly effective.

Other options which are safe for pregnancy include hydralazine, prazosin, or clonidine.

## Magnesium Infusion for Seizure Prophylaxis

### Magnesium Basics

- Should be given to any critically ill, preeclamptic woman to reduce risk of seizure (unless contraindicated by myasthenia gravis, heart block, or severe hypocalcemia).
- Magnesium levels aren't routinely monitored in women with normal renal function. If levels are checked, they may be interpreted roughly as shown below.⁹
  - **Make sure to use the appropriate units!** There are three different units in clinical use, so it's easy to get confused.
  - If you are going to check magnesium levels, consider also checking electrolytes and calcium as well.
- The optimal duration of the magnesium infusion is unclear. Treatment is often continued until ~24 hours after delivery, when the patient is showing clinical signs of resolving preeclampsia.

### Table 2. Serum Magnesium Concentration and Toxicities

<table>
<thead>
<tr>
<th>Serum Magnesium Concentration</th>
<th>mEq/L</th>
<th>mg/dL</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>2–3.5</td>
<td>4–7</td>
<td>5–9</td>
<td>Therapeutic range</td>
</tr>
<tr>
<td>&gt;3.5</td>
<td>&gt;7</td>
<td>&gt;9</td>
<td>Loss of patellar reflexes</td>
</tr>
<tr>
<td>&gt;5</td>
<td>&gt;10</td>
<td>&gt;12</td>
<td>Respiratory paralysis</td>
</tr>
<tr>
<td>&gt;12.5</td>
<td>&gt;25</td>
<td>&gt;30</td>
<td>Cardiac arrest</td>
</tr>
</tbody>
</table>

ACOG Practice Bulletin 2019 PMID 30975675

### Typical Regimen

- Load with 6 grams IV magnesium sulfate (24 mM).
- Infuse magnesium at 1-2 grams/hour (4-8 mM/hour) (some newer data and guidelines suggest that 1 gram/hour may be adequate)²¹⁰
- 2 grams/hour (8 mM/hr) – may be more appropriate for higher weight & antepartum patients.

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The Internet Book of Critical Care, by @PulmCR
1 gram/hour (4 mM/hr) – may be more appropriate if mild renal insufficiency (Cr 1-2.5) and/or mild oliguria.

- Monitor carefully. Hold the infusion and check levels if signs of magnesium toxicity or renal failure:
  - Signs of magnesium toxicity: loss of patellar reflexes, tachypnea due to respiratory muscle weakness
  - Reduced urine output: acute kidney injury will eventually lead to magnesium accumulation

**treatment with severe oliguria or creatinine >2.5 mg/dL**

- Load with 4-6 grams IV magnesium sulfate (16-24 mM).
- Follow electrolytes & magnesium levels q4-6hr.
- Bolus with magnesium based on levels (don't use a maintenance infusion).

**side-effects**

- Common side-effects include flushing, mild hypotension, and muscle weakness.
- Severe magnesium toxicity may cause respiratory depression or heart block. The treatment is IV calcium.
- Magnesium can suppress parathyroid hormone production, leading to symptomatic hypocalcemia. Treatment is cessation of the magnesium infusion and (again) administration of IV calcium.

**seizure management**

**immediate therapy**

- Most eclamptic seizures are self-limited.
- Magnesium is the front-line antiepileptic to prevent seizure recurrence.
  - If patient hasn't yet received magnesium, load with 6 grams IV and infuse as above.
  - If patient has received magnesium, consider re-loading with 2-4 grams IV.
  - Infusion or maintenance doses as described above
- Benzodiazepine may be used for status epilepticus (e.g., ongoing generalized seizure >5 minutes).
  - IV access: Lorazepam 0.1 mg/kg IV bolus
  - No IV access: Midazolam 10 mg IM

**seizure refractory to benzodiazepine & magnesium**

- This is unusual and may suggest another process (e.g. intracranial hemorrhage).
- Consider early intubation and propofol infusion.
- Levetiracetam may be added as a second-line agent after magnesium.

**diagnostics & neuroimaging**

- Fingerstick glucose immediately, to exclude hypoglycemia
- Additional laboratory studies (if not already available).
- Consider imaging to exclude other pathology (e.g. intracranial hemorrhage, cerebral venous thrombosis). Patients with eclampsia will often have imaging features of PRES, as these two conditions may overlap substantially.
  - More on PRES [here](https://emcrit.org/ibcc/hypertensive-emergency/#PRES_(Posterior_reversible_encephalopathy_syndrome)).

**treatment of HELLP syndrome**

**(don't forget the treatment for preeclampsia)**

- HELLP is a subset of preeclampsia. Therefore, patients with HELLP also have preeclampsia
  - Magnesium infusion is indicated in HELLP syndrome, as these patients are at risk for seizure.
  - If hypertension is present, it should be treated in the same fashion as preeclampsia in general (see above).

**subcapsular liver hematoma**
• Should be suspected in any patient with preeclampsia/HELLP with RUQ pain.
• Diagnosis is based on ultrasonography.
• Treatment includes optimization of coagulation factors, large bore IV access, emergent surgery and/or angiographic embolization to treat hepatic rupture, and potentially even liver transplant.
  • Get all hands on deck early (e.g. trauma surgeons with expertise in liver injury and transplant teams).

**complement-directed therapy?**

• Growing evidence indicates that HELLP could share many similarities with atypical hemolytic uremic syndrome (aHUS), which is caused by dysregulated complement activation.\textsuperscript{11} \textsuperscript{12}
• One case report describes successful treatment of HELLP with eculizumab (a complement inhibitor).\textsuperscript{13} This might be considered in cases of HELLP which closely resemble atypical hemolytic uremic syndrome (e.g. prominent microangiopathic hemolytic anemia with low complement levels).

**delivery & post-delivery course**

• As with preeclampsia in general, severe HELLP is an indication for delivery.
• Deterioration may continue for two days after delivery, but improvement should subsequently occur. If deterioration continues for four days after delivery, consider alternative diagnostic possibilities (e.g. atypical hemolytic uremic syndrome, thrombotic thrombocytopenic purpura).\textsuperscript{9}

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**fetal monitoring & delivery**

**fetal monitoring**

• As per Obstetrics team.
• Note that the fetus is a maternal end-organ, so fetal distress can be an early sign of systemic hypoperfusion (shock).
  • If fetal stress is a symptom of maternal shock, then both delivery and maternal resuscitation may be required simultaneously.

**delivery**

• Definitive treatment of preeclampsia/HELLP is delivery of the fetus.
• If expedited delivery is possible and the fetus is pre-term (<37 weeks), consider steroid administration to promote fetal lung maturity.
• This decision will be made by obstetrics. Indications for delivery may include:
  • Gestational age >37 weeks (term pregnancy)
  • Refractory HTN despite three classes of antihypertensive agents
  • Progressive thrombocytopenia
  • Progressively worse renal or liver tests
  • Pulmonary edema
  • Worsening neurologic features (e.g. intractable headache, repeated visual scotomata, or seizures)
  • Non-reassuring fetal status, suspected placental abruption, rupture of membranes.

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**other issues**

**disseminated intravascular coagulation (DIC)**

• Follow coagulation studies.
• Factor replacement may be needed prior to delivery or if there is active bleeding.
  • Note that fibrinogen targets in post-partum hemorrhage may be somewhat higher than in most patients (e.g. >200 mg/dL).
• Consider whether DIC may be caused by placental abruption.\textsuperscript{14}

**acute kidney injury**

• There is no specific therapy for renal failure other than supportive care and avoidance of nephrotoxins.
- Consider other possible causes of kidney injury including glomerulonephritis, thrombotic thrombocytopenic purpura, or atypical hemolytic uremic syndrome. These may require specific treatment.
- Perfusion should be optimized as discussed above, with cautious use of fluids. Note that these patients often have leaky capillaries, so large-volume fluid resuscitation is unhelpful (may merely worsen pulmonary & systemic edema).

**other complications to be aware of**

- Intracranial hemorrhage
- Retinal detachment

**DVT prophylaxis**

- Preeclampsia, immobility, and pregnancy are all risk factors for venous thromboembolism.
- DVT prophylaxis should be determined in coordination with the Obstetrics team, as this may affect spinal anesthesia & delivery.

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### checklist & tables

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#### Preeclampsia checklist

- Labs
  - Glucose, electrolytes including Ca/Mg/Phos, CBC
  - Liver function tests, amonnia
  - Coagulation studies, fibrinogen, D-dimer, LDH, haptoglobin
  - Urinalysis & spot protein/creatinine ratio
  - If infection suspected: cultures, lactate
- Imaging
  - Obstetric ultrasonography (e.g. if abruptio possible)
  - For neuro/visual changes: consider CT/MRI brain (t/r ICH), retinal exam (t/r detach)
  - For right upper-quadrant pain: ultrasound to exclude subcapsular liver hematoma
- Control Bp
  - Drop MAP by ~20% over a few hours, then gradually reduce to ~105-115 mm
- Nicardipine infusion preferred (or IV labetalol)
- Magnesium infusion
  - Load with 6 grams IV (24 mm)
  - Maintenance regimen
    - Creatinine <1 mg/dL: 2 grams/hour infusion (8 mm/hr)
    - Creatinine 1-2.5 mg/dL: 1 gram/hour infusion (4 mm/hr)
    - Creatinine >2.5 mg/dL: No infusion, use PRN boluses.
    - Therapeutic target: 5-7 mg/dL (2-3.5 mm)
  - Watch for: oliguria, loss of reflexes, respiratory muscle weakness
- Obstetrics consultation
  - Fetal monitoring
  - ? Steroid for lung maturation, ? Expedited delivery

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#### initial antihypertensive agents for preeclampsia

<table>
<thead>
<tr>
<th>Agent</th>
<th>Pro</th>
<th>Con</th>
<th>Contraindications, Cautions</th>
<th>Onset &amp; duration</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV Nifedipine</td>
<td>Effective, more easily titrated than labetalol.</td>
<td></td>
<td>Cribosis (severely by liver)</td>
<td>Onset ~15 min. Lasts 1-2 hours.</td>
<td>2-5-15 mg/hour. When Bp at target, consider reducing infusion to 5 mg/hr to prevent accumulation. If Bp below target, decrease infusion to 2.5 mg/hr or stop entirely.</td>
</tr>
<tr>
<td>IV Labetalol</td>
<td>Traditional agent of choice.</td>
<td>Can cause bradycardia.</td>
<td>Beta-1 selective beta-blocker, as it may cause hypotension.</td>
<td>Onset 5-15 min. Lasts 3-6 hours.</td>
<td>Load with sequential pushes of 20mg, 40mg, 80mg, 160mg (q15 min PRN). If a total dose of 200 mg doesn’t work, switch to another agent. Once Bp controlled, may use intermittent bolus to keep in range.</td>
</tr>
<tr>
<td>IV Nitroglycerin</td>
<td>Useful in patients with volume overload, cardiogenic pulmonary edema, or intercurrent myocardial ischemia.</td>
<td>Headache</td>
<td>Phosphodiesterase inhibitors use (e.g. sildenafil) 48 hours. Elevated intracranial pressure</td>
<td>Onset 2 minutes. Lasts 10 min.</td>
<td>0-300 mcg/min</td>
</tr>
<tr>
<td>IV Hydralazine</td>
<td>Unpredictable efficacy; May cause overshoot hypotension.</td>
<td>Associated with more abnormal fetal heart rate tracing.</td>
<td>Headache, tachycardia</td>
<td>Onset ~10 minutes. Lasts ~4 hours.</td>
<td>Start with 5 mg IV, Then additional 5-10 mg doses as needed every 20-40 minutes (to a maximal dose of ~40 mg total used initially). Can cause overshoot hypotension – start slow and go slow.</td>
</tr>
<tr>
<td>Oral nifedipine (immediate release)</td>
<td>May be useful in situations with limited IV access.</td>
<td>May cause overshoot hypotension.</td>
<td>Headache, tachycardia</td>
<td>Onset ~20 minutes. Lasts ~6 hours.</td>
<td>10 mg PO, repeat every 30-60 minutes as needed (no more than 50 mg total used initially).</td>
</tr>
</tbody>
</table>

*Not generally preferred as front-line agents; may be used if other agents are unavailable or ineffective.*
long-acting oral anti-hypertensives for preeclampsia

<table>
<thead>
<tr>
<th>Agent</th>
<th>Pro</th>
<th>Con</th>
<th>Contraindication &amp; caution</th>
<th>Onset &amp; duration</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labetalol</td>
<td>- Usually preferred oral antihypertensive</td>
<td>- Can cause bradycardia</td>
<td>- Bradycardia</td>
<td>Onset in ~2 hr</td>
<td>Start 200 mg q12hr</td>
</tr>
<tr>
<td></td>
<td>- More effective than most beta-blockers (e.g. metoprolol)</td>
<td></td>
<td>- Heart block or sick sinus syndrome</td>
<td>Duration ~10 hr</td>
<td>Max dose 1000 mg q12hr</td>
</tr>
<tr>
<td></td>
<td>- Safe in lactation</td>
<td></td>
<td>- Cardiogenic pulmonary edema</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nifedipine, extended</td>
<td>- Similar to amlopidine but faster acting</td>
<td>- Cannot be crushed for administration via feeding tube</td>
<td>- Renal clearance, may accumulate in acute kidney injury</td>
<td>Onset in ~2-4 hr</td>
<td>Starting dose 30 mg daily</td>
</tr>
<tr>
<td>release</td>
<td>- Safe in lactation</td>
<td></td>
<td>- Hepatitis or coarctation</td>
<td>Duration ~24 hr</td>
<td>Max 120 mg daily</td>
</tr>
<tr>
<td>Methylodopa</td>
<td>- Extensive track record for preeclampsia, very safe in pregnancy</td>
<td>- Slow onset, takes a long time to reach steady state efficacy (hard to predict)</td>
<td>- Renal insufficiency</td>
<td>Onset in 3-6 hours</td>
<td>Starting dose 250 mg q8hr</td>
</tr>
<tr>
<td></td>
<td>- Safe in lactation</td>
<td></td>
<td>- May cause azotemia</td>
<td></td>
<td>Adjust dose every two days</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- HOCM or LV outflow tract obstruction</td>
<td></td>
<td>Max dose ~1,000 mg q8hr</td>
</tr>
<tr>
<td>Hydralazine</td>
<td>- Safe in lactation</td>
<td>- May cause reflex tachycardia &amp; fluid retention</td>
<td>- May cause azotemia</td>
<td>Onset in 1 hour</td>
<td>Start 25 mg q8hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Due to reflex tachycardia, may be best used in combination with labetalol, methylodopa, or clonidine.</td>
<td></td>
<td>Duration ~6 hrs</td>
<td>Max dose 100 mg q8hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Renal clearance, may accumulate in acute kidney injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prazosin</td>
<td>- Safe in pregnancy, may be used if other agents ineffective or unavailable</td>
<td>- Rarely used for preeclampsia</td>
<td></td>
<td>Onset ~2 hours</td>
<td>Start 1-2 mg q12 hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Sustained-release action</td>
<td></td>
<td>Duration ~12 hrs</td>
<td>Max dose 10 mg q12 hr</td>
</tr>
<tr>
<td>Clonidine</td>
<td>- May provide some anxiolysis.</td>
<td>- Abrupt discontinuation may cause rebound hypertension</td>
<td>- May cause azotemia</td>
<td>Onset in 1 hour</td>
<td>Start 2 mg PO q12hr</td>
</tr>
<tr>
<td></td>
<td>- Rapid onset</td>
<td></td>
<td></td>
<td>Duration ~12 hrs</td>
<td>Max dose 1.2 mg PO q12hr</td>
</tr>
</tbody>
</table>

1. Typically first-line agents.

[The Internet Book of Critical Care, by @PmCRIT](https://emcrit.org/wp-content/uploads/2016/12/eclamps2.svg)

### Podcast

[Click here to listen](https://i1.wp.com/emcrit.org/wp-content/uploads/2016/11/apps.40518.14127333176902609.7be7b901-15fe-4c27-863c-7c0dbfc26c5c-e278f58-912b-4af9-88f8-a65ff2da477.jpg)


### The Podcast Episode

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### Questions & Discussion

To keep this page small and fast, questions & discussion about this post can be found on another page [here](https://emcrit.org/pulmcrit/preeclampsia/).
Going further:

- [Preeclampsia & eclampsia](https://lifeinthefastlane.com/ccc/pre-eclampsia-and-eclampsia/) (Chris Nickson, LITFL)
- [Preeclampsia & eclampsia](https://coreem.net/podcast/episode-113-0/) (Anand Swaminathan and Jenny Beck-Esmay, CoreEM)

References

1. Protein/Cr ratio is calculated from quantitative measurements of protein and creatinine from a single urine sample. This provides a reasonable estimate of the daily protein excretion, without waiting for a 24-hour urine collection.


