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DIFFERENTIAL DIAGNOSIS OF PREGNANCY-ASSOCIATED MYOCARDIAL INFARCTION

- Aortic dissection

- ↑Risk during pregnancy and the postpartum period.
 - Patients with connective tissue diseases such as Marfan syndrome, Loays-Dietz, Ehlers-Danlos Type IV, familial aortopathy, Turner syndrome, bicuspid disease or other preexisting aortopathies are at greatest risk and require specific preconceptual counseling.
 - Most maternal deaths occur in women without a preexisting diagnosis; in those cases, aortopathy can be identified post-mortem for guidance of future familial care.
- Pulmonary embolism

- ↑4-fold risk in the peripartum period with half of all events occurring postpartum.
 - Diagnosis can be confirmed with ventilation-perfusion scan, computed tomographic pulmonary angiogram or magnetic resonance imaging.
- TCM

- Takotsubo cardiomyopathy (TCM) has been described in 2.3% of women presenting with pregnancy-associated myocardial infarction (PAMI) undergoing coronary angiography.
 - Labor and delivery can serve as an emotional and/or physical trigger for some patients.
 - Given the prevalence of spontaneous coronary artery dissection (SCAD) in PAMI, patients with suspected peripartum TCM should be carefully considered for SCAD.
- PPCM

- Peripartum cardiomyopathy (PPCM) presents as new-onset heart failure at the end of pregnancy or the months after delivery.
 - Severe cases can present with ventricular arrhythmias and/or cardiac arrest, which may warrant a work-up for PAMI.
- Myocarditis

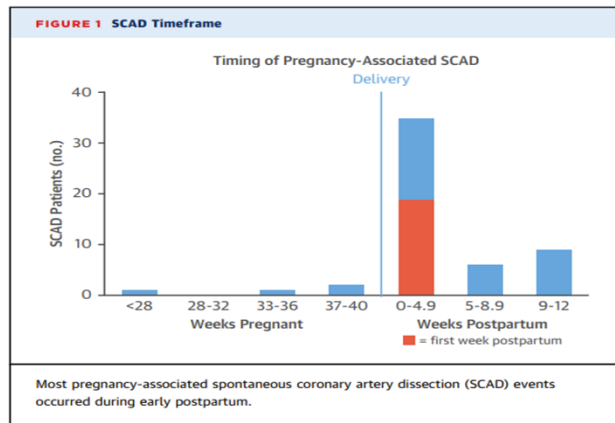
- In the setting of concurrent pericarditis, myocarditis can present with acute chest pain and ST-segment elevations.
 - The incidence of myocarditis is not known to be ↑ during pregnancy and should be considered as suggested by the clinical context.
 - Newly diagnosed heart failure is also suspicious for PPCM. Cardiovascular magnetic resonance imaging can be helpful. As gadolinium contrast crosses the placental barrier, use is avoided during pregnancy unless deemed absolutely necessary.
- Pre-eclampsia

- Preeclampsia affects up to 8% of pregnancies and is diagnosed in women with new-onset hypertension and proteinuria or end-organ dysfunction in a pregnant woman after 20 weeks gestation.
 - The acute treatment of preeclampsia includes antihypertensive therapy, diuresis, and delivery (contingent on gestational age).

Tweet et al. Circulation: Cardiovascular Interventions 2020.

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SCAD OCCURENCE



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SCAD RISK FACTORS

- **Who is at risk?**
- Ninety percent of SCAD cases are women, mostly between 30- 60 years old. SCAD accounts for about 25% of all heart attacks in women under 60 years old.
- Other risk factors include:
 - fibromuscular dysplasia (FMD)
 - connective tissue disorders
 - systemic inflammations
 - cocaine use
 - severe emotional stress
 - intense physical exertion
 - hormonal therapy with estrogen & progesterone

AllinaHealth

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PREGNANCY RELATED SCAD

- Pregnant and post-partum women are also at risk of SCAD. The strain of pregnancy and labor can add to the stress on weaker blood vessels, leading to a tear. P-SCAD is a very rare pregnancy-associated SCAD that could lead to a heart attack if not treated as soon as symptoms appear.

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CAUSES OF SCAD

- The cause of SCAD is still unknown. It is believed that it starts within an intimal arterial wall weakening. Possible causes of weakened artery walls are:
 - fibromuscular dysplasia
 - genetics
 - multiple pregnancies
 - connective tissue disorders
 - systemic inflammations (like Crohn's disease)
 - hormonal changes/therapy
 - cocaine use
- SCAD can also be triggered by highly emotional events (death of loved one, job loss, breakdown of marriage) or physical stresses (giving birth, weight lifting, intensive workout, straining bowel movement, coughing, retching/vomiting,). In a [recent study](#), more than half of patients experienced an emotionally or physically stressful event around the time of their SCAD.

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SCAD

CENTRAL ILLUSTRATION Features of Pregnancy-Associated Spontaneous Coronary Artery Dissection

Spontaneous Coronary Artery Dissection (SCAD)	Pregnancy-associated SCAD (P-SCAD)	Recommended areas of P-SCAD research:
<p>A coronary artery hematoma ± tear limits coronary blood flow to the myocardium</p>  <p style="text-align: center;">Hematoma</p> <p style="text-align: center;">Tear in arterial wall</p>	<ul style="list-style-type: none"> • Frequently occurs in first month postpartum (majority of these within first week after delivery) • P-SCAD presentation often severe: <ul style="list-style-type: none"> - ST-segment elevation myocardial infarction - Reduced left ventricular function - Left main and/or multivessel SCAD • Compared to non-pregnancy-associated SCAD: <ul style="list-style-type: none"> - P-SCAD has a higher risk presentation - P-SCAD patients are older at time of first childbirth and more frequently have history of multiple pregnancies - P-SCAD patients have fewer extracoronary vascular abnormalities 	<ul style="list-style-type: none"> 🔍 Hemodynamic stressors 🔍 Hormonal fluctuations 🔍 Oxytocin release in breastfeeding mothers 🔍 Older, multiparous mothers 🔍 Relationship to: <ul style="list-style-type: none"> - Eclampsia/pre-eclampsia - Peripartum cardiomyopathy - Fibromuscular dysplasia and other extracoronary vascular abnormalities

Tweet, M.S. et al. J Am Coll Cardiol. 2017;70(4):426-35.

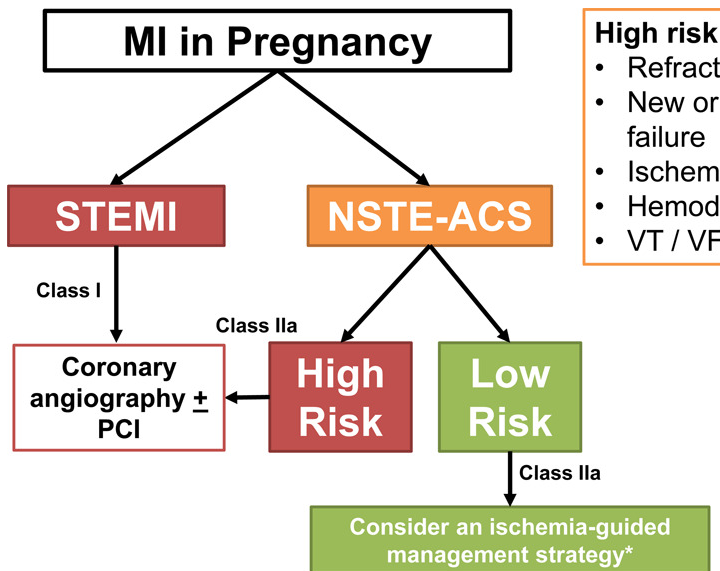
In this study, pregnancy-associated spontaneous coronary artery dissection (P-SCAD) was found to occur most frequently in the first month postpartum, and patients often presented with ST-segment elevation myocardial infarction or reduced left ventricular function. The underlying mechanisms are likely multifactorial and not well understood. P-SCAD = spontaneous coronary artery dissection during or shortly following pregnancy; SCAD = spontaneous coronary artery dissection.

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MI in Pregnancy

High risk NSTEMI-ACS:

- Refractory angina
- New or worsening heart failure
- Ischemic mitral regurgitation
- Hemodynamic instability
- VT / VF



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graph TD
    MI[MI in Pregnancy] --> STEMI[STEMI]
    MI --> NSTEMI[NSTEMI-ACS]
    STEMI -- Class I --> Angio[Coronary angiography ± PCI]
    NSTEMI -- Class IIa --> HighRisk[High Risk]
    NSTEMI -- Class IIa --> LowRisk[Low Risk]
    HighRisk -- Class IIa --> Angio
    LowRisk -- Class IIa --> Ischemia[Consider an ischemia-guided management strategy*]
    
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Tweet et al. Circulation: Cardiovascular Interventions 2020.

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Medication	Use in patient with PAMI?	Indications	Caveats
Antenatal corticosteroids (either betamethasone or dexamethasone)	Yes.	Should be administered if delivery is expected within the next 7 days; a course consists of either betamethasone (12mg IM every 24 hours x2 doses) or dexamethasone (6mg IM every 12 hours x4 doses) and may be repeated once prior to 34 weeks gestation if preterm delivery has not occurred but is again considered imminent.	Although either drug may exert mineralocorticoid activity to a small degree, fluid retention and pulmonary edema have only been described with other contributing factors (tocolytic medications, multiple gestation, and intra-amniotic infection). A transient interval of hyperglycemia is common in diabetic patients.
Carboprost tromethamine	With Caution.	Uterotonic agent to treat postpartum hemorrhage.	May cause secondary hypertension.
Magnesium sulfate	Yes.	Administered intravenously for fetal neuroprotection prior to 32 weeks gestation, to effect seizure prophylaxis in patients with preeclampsia or eclampsia, and infrequently as a tocolytic medication.	Cardiovascular side-effects include hypotension (with bolus administration) and bradycardia.
Methylergonovine	No.	Uterotonic agent to treat postpartum hemorrhage.	Can cause coronary arterial spasm, so this should be avoided.
Oxytocin	With Caution.	Typically given to augment uterine contractility, either during labor or immediately postpartum.	Associated with hypotension and ventricular arrhythmias.
Terbutaline	No.	A beta-mimetic compound utilized intrapartum to treat uterine tachysystole (excessive contraction frequency).	It should be avoided as tachycardia and arrhythmias are common side-effects.
Tranexamic acid	No.	An antifibrinolytic agent utilized to augment hemostasis in postpartum hemorrhage.	Use is contraindicated with active thrombosis.



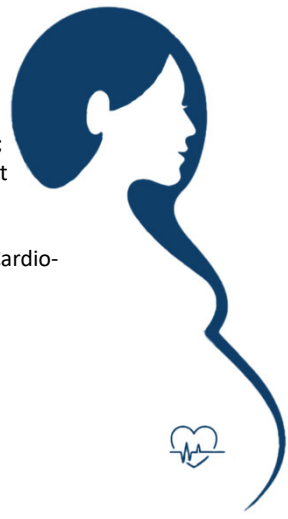
Edited from: Tweet et al. Circulation: Cardiovascular Interventions 2020.

Recommendations for management of P-SCAD patients in the cardiac catheterization laboratory.

These work for STEMI regardless of etiology

1. Patients with STEMI on their presenting ECG should have urgent coronary angiography to define coronary anatomy.
2. Patients without STEMI on their presenting ECG but with significant troponin rise or ongoing chest pain should be considered for early coronary angiography to define coronary anatomy.
3. Thrombolysis should be avoided in cases of pregnant patients with STEMI and urgent angiography facilitated.
4. During angiography, the patient's right hip should be supported (i.e., with a wedge or pillow) so that the patient is tilted to the left. This reduces the risk of IVC compression and consequent reduction in cardiac preload.
5. Radial access should be first-line choice of access, to minimise direct screening of the abdomen with radiation.
6. The abdomen should be shielded with lead throughout the case.
7. Radiographers should ensure that radiation delivery, field size and frame rate are all optimised to ensure minimum radiation (while ensuring interpretable pictures).
8. Obstetric monitoring facilities (i.e. CTG) should be brought to the catheterization laboratory to provide appropriate foetal monitoring throughout the case
9. An obstetrician and peri-mortem Caesarean section equipment should be available throughout the case, if gestational age is > 24 weeks. In case of maternal cardiac arrest, the baby should be delivered within 5 min of arrest, while maternal resuscitation efforts continue.
10. P-SCAD should be managed conservatively with optimal medical therapy unless the patient has left main dissection, is haemodynamically unstable or experiencing refractory arrhythmias.

If unable to get to cath lab within 90 minutes, then ½ dose lytic IS recommended; Best to speak with cardiologist First.
(Personal communication: Dr Retu Saxena, Co-Director Cardio-Obstetrics Program)



Thrombolytics?

- Literature review up to 2017; 65 articles, 141 women; DVT, PE, stroke, prosthetic valve thrombosis; various lytic agents
- 4 maternal deaths (2.8%), none related to lytic rx
- 2 fetal losses
- 12 major bleeding events (8.5%)
- 9 miscarriages (6.4%)
- 14 preterm delivery (9.9%)
- Teratogenic effects not described
- **Conclusion:** "A decision to employ thrombolytics in pregnancy would seem reasonable taking into account the risk of death in the setting of a life-threatening event, with the majority of cases presented in this article resulting in encouraging outcomes. The complication rate of thrombolytic treatment does not seem higher in pregnant women than in the nonpregnant... Specific consensus recommendations are needed in the use of thrombolytics in obstetrics."



Gomes et al. Thrombolysis in pregnancy: literature review. J MFM Neo Med 2019. 32(14). 2418.

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NEUROLOGIC EVENTS

Ischemic Stroke

- IV alteplase may be considered in pregnancy when the anticipated benefits of treating moderate or severe stroke outweigh the anticipated increased risks of uterine bleeding. (Weak but benefit \geq risk, limited evidence)
- Discuss with stroke neurologist immediately
- Transfer to stroke center ASAP



Powers et al. Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines. Stroke 2019;50(12).

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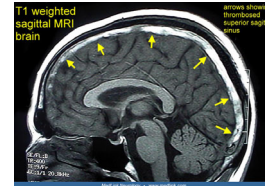
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NEUROLOGIC EVENTS

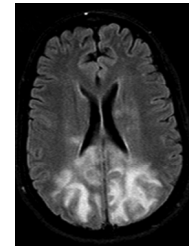
Cerebral venous thrombosis (CVT)

- often after delivery
- Headache and/or stroke in venous distribution
- Full heparin anticoagulation until delivery; warfarin after



Reversible posterior leukoencephalopathy syndrome (RPLS) or PRES

- Risk factors: HTN emergency, (pre)eclampsia, peripartum seizures, certain immunosuppressants
- Seizures
- Postpartum blindness
- Treat blood pressure as HTN emergency



Fischer M. J Neurol 2017;264(8):1608

Is it eclampsia or is it status epilepticus?

Pregnant women with history of epilepsy

- Common seizure meds often have reduced serum levels in pregnancy (lamotrigine, Levetiracetam, carbamazepine, lacosamide)

New onset status epilepticus in pregnancy (NOSEP)

- Is it eclampsia, or something else? (CVT, PRES, stroke, metabolic, toxin, TTP/HUS,...)
 - If eclampsia → Magnesium
 - If no eclampsia findings or still seizing after > 5 minutes, use lorazepam 4mgIV, then consider Levetiracetam for its immediate loading dosing and efficacy
 - Image as needed for proper evaluation, but avoid gadolinium

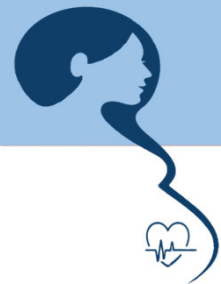
ENDOCRINE



Diabetic Keto Acidosis (DKA)

Hyperglycemic hyperosmolar syndrome (HHS)

DKA: a metabolic emergency



- Pregnancy is associated with an increase in insulin-antagonizing hormones such as human placental lactogen, estrogen, and prolactin, which contribute to a more than 50% reduction in insulin sensitivity by the third trimester
- Pregnancy is considered a state of accelerated starvation with enhanced lipolysis and ketone body production even with relatively short periods of fasting
- Pregnant women also experience increased minute alveolar ventilation leading to respiratory alkalosis with compensatory increased renal excretion of bicarbonate and a lower buffering capacity

DKA: a metabolic emergency



- Reported incidence ranging from 0.5% to 10% of pregnancies affected by pregestational diabetes
- Associated maternal mortality is rare, but reported **fetal mortality ranges from 10% to 35%**
- Substantial morbidity among infants and women (AKI, Fetal Demise, preterm labor, Preterm delivery) with DKA event during pregnancy (not just at delivery)
- Start treating immediately with fluids, K replacement, insulin, AND
- TRANSFER to higher level Maternal Care Center if severe features

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DIABETIC KETOACIDOSIS TREATMENT

FOR MORE DETAILS OF MANAGEMENT SEE DKA IN PREGNANCY PROTOCOL
TENETS OF MANAGEMENT:

- Aggressive hydration, use normal saline
- IV insulin (may need to give D5 in order to facilitate insulin administration in euglycemic DKA, which is more common in pregnancy)
- Correction of underlying etiology

Fluid resuscitation

- Fetal assessment – Classical teaching is to not intervene while patient is in DKA
- Aggressive hydration, use normal saline
 - 1 L in first hour
 - Hours 2-4 0.5-1L/hour
 - Thereafter: give 250 mL/h 0.45NS until 80% deficit corrected
 - Once BG < 300 mg/dL, change IV fluids to D51/2NS and follow intrapartum IV insulin algorithm (Refer to Veciana & Evans 2007).

Insulin

- Loading dose of 0.1-0.4 units/kg
- Maintenance of 2-10 units/hour (start with insulin gtt in labor protocol and adjust as necessary). Double insulin infusion rate if BG does not decrease by 20% in first 2 hours if hyperglycemic
- Continue insulin therapy until bicarbonate/anion gap normalize (serum GB/potassium/anion gap)

Potassium replacement

- If K is initially normal or reduced, consider an infusion of K of up to 15-20 mEq/h
- If K is elevated, do not add supplemental K until levels are normal, then 20-30 mEq/L
- Phosphate – consider replacement if serum phosphate < 1.0 mg/dL or cardiac dysfunction present or patient obtunded

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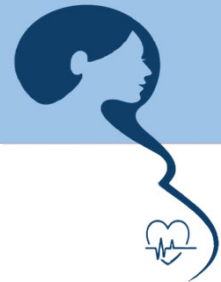
“Euglycemic” DKA: still a metabolic emergency



- “euglycemic DKA” type characterized by metabolic acidosis and increased total body ketone concentration, but with glucose levels ≤ 250 mg/dL, occurring in approximately 10% of patients with DKA

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ENDOCRINE Hyperglycemic hyperosmolar syndrome (HHS)



- Findings:
 - altered consciousness, varying from confusion or disorientation to coma
 - extreme dehydration
 - with or without prerenal azotemia,
 - hyperglycemia, and hyperosmolality. In contrast to diabetic ketoacidosis,
 - focal or generalized seizures and transient hemiplegia may occur.
- The fluid deficit can exceed 10 L
- Acute circulatory collapse is a common cause of death.
- Widespread thrombosis is a frequent finding on autopsy and in some cases
- Bleeding may occur as a consequence of disseminated intravascular coagulation
- Maternal mortality up **to 20%**
- FLUIDS: Normal saline, potassium; no insulin until osmolality stops falling
- Remember to correct serum sodium for serum glucose by adding 1.6 mEq/L (1.6 mmol/L) for each 100 mg/dL (5.6 mmol/L) elevation of serum glucose over 100 mg/dL (5.6 mmol/L)
- Target rate of change of sodium is no faster than 0.5 mEq/hour
- Target reduction of serum glucose is no faster than 90 mg/dl/hour
- Reduction in serum osmolality target range is 3.0–8.0 mOsm/kg/h, using fluids and judicious insulin
- Too rapid reduction in osmolality risks cerebral edema and osmotic demyelination

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Thank you for all your support over the years

"In this life, everything has a beginning and an end. And I think it's an appropriate time to put an end to a career that has been long and much more successful than I could have ever imagined." Rafael Nadal 2024

"The names of the patients whose lives we save can never be known. Our contribution will be what did not happen to them. And, though they are unknown, we will know that mothers and fathers are at graduations and weddings they would have missed, and that grandchildren will know grandparents they might never have known, and holidays will be taken, and work completed, and books read, and symphonies heard, and gardens tended that, without our work, would never have been."

Don Berwick, MD, 2004 IHI's 16th Annual National Forum on Quality Improvement in Health Care



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