ASK THE EXPERTS

PE and Pregnancy: What's Your Algorithm?

Considerations regarding diagnosis and management for pulmonary embolism in pregnant patients.

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The management of pulmonary embolism (PE) has grown and diversified over the last 2 decades. Due in large part to the work of the multidisciplinary PERT Consortium, there is increasing national awareness of this disease process, although it remains the third-leading cause of cardiovascular death in the United States.[1] With the development of PE response teams (PERTs), there has been an investment by hospitals to facilitate multidisciplinary care of patients with intermediate- and high-risk PE. Unfortunately, there is not one device to date that caters to treatment of all PE. Considering this, there are many devices currently being developed or investigated to facilitate safe and effective treatment of thrombus. To date, the focus has been intermediate-risk PE. However, assuming a benefit is shown in this patient population, it is foreseeable that this therapy will be extended to lower-risk patients.

Despite advances in medical care and medical therapy, PE-associated death continues to rise. Notably, PE still accounts for 9.2% of pregnancy-related deaths in the United States.[2,3] Pregnancy itself is associated with increased thrombotic risk, and it is important to recognize that women tend to be at the highest risk for venous thromboembolism (VTE) in the 6 weeks postpartum.[4]

DIAGNOSIS AND IMAGING

As clinical providers, our index of suspicion must be high for PE in the right clinical context in pregnancy. Multiple clinical decision tools exist, including the YEARS algorithm, which considers clinical signs of deep vein thrombosis, hemoptysis, and whether PE is the most likely diagnosis as well as use of compression ultrasound.[5,6] There is often hesitation obtaining definitive diagnostic imaging given a fear regarding radiation exposure, which is most significant in the first trimester. However, CT pulmonary angiography is associated with 0.01 to 0.66 mGy of radiation exposure, and a peripheral or coronary angiogram with intervention is associated with 0.0023 to 0.012 mGy/min. Fetal risk is considered negligible when radiation exposure is < 50 mGy.[7]

MANAGEMENT

Once the diagnosis has been confirmed, as in other patients with VTE, the forefront of medical therapy is effective anticoagulation. During pregnancy, this is most effectively and safely done using heparin products, such as low-molecular-weight heparin (LMWH). This often needs to be monitored closely during pregnancy with weight gains, and LMWH anti-Xa assays are followed. Venous duplex ultrasound imaging of the lower extremities is critical to assess thrombus burden; this often extends only to the common femoral vein. In the right clinical context, iliac and caval ultrasound imaging may be necessary to further establish extent of thromboembolic disease. This is particularly important in patients with asymmetric leg swelling and those with monophasic flow in the proximal common femoral vein suggestive of more proximal obstruction (which may be

PE IN PREGNANCY: TOP TAKEAWAYS

- Pregnant people have increased thrombotic risk.
- Decision tools should be used to aid in diagnosis.
- Do not delay diagnostic imaging due to fear of radiation; fetal risk is negligible with radiation exposure < 50 mGy.
- Heparin and LMWH are safe and effective anticoagulation options during pregnancy.
- Catheter-based intervention and ECMO are also safe options but decisions should be made in collaboration with a PERT, cardio-obstetrics, and a high-risk maternal-fetal medicine specialist.

physiologic in the setting of a gravid uterus, resulting in some degree of venous compression).

Given the complexity of care in these patients, management should always be based on multidisciplinary communication and collaboration, often with a high-risk maternal-fetal medicine physician, cardio-obstetrics physician, hematologist, and vascular expert. In the acute setting in intermediate- or high-risk patients, engaging with a PERT is critical in caring effectively for these patients. In intermediate- and high-risk patients, it is clinically appropriate to discuss potential need for catheter-based interventions, favoring thrombectomy over lytic therapy, if clinically feasible, given the additional fetal risk with use of lytic therapy. If catheter-based intervention is pursued, limiting radiation exposure to the fetus is key.

In patients with shock, engaging the shock team and having resources available for extracorporeal membrane oxygenation (ECMO) cannulation can be critical. From a longitudinal perspective, patients require close follow-up after hospital discharge to facilitate appropriate management and dosing of anticoagulation throughout the pregnancy and at the time of delivery. Patients often require counseling regarding the safety and approach to future pregnancies. This is best done with multidisciplinary follow-up involving cardio-obstetrics, hematology, vascular, and high-risk maternal-fetal medicine.

CONCLUSION

The diagnosis of PE in pregnancy is challenging, and decision-making tools, such as YEARS criteria, should be used to guide clinicians. Clinicians should not delay definitive diagnostic imaging due to fear of radiation exposure. Use of catheter-based interventions and ECMO are safe options, particularly when delivered by clinical experts in a multidisciplinary fashion.

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PE remains a leading cause of pregnancy-related mortality.[1] Pregnancy is a unique situation as the concerns of both the mother and fetus play a role in diagnosis and management of PE in this patient population.

Pregnant patients are at elevated risk for PE due to a combination of the hormonal changes, hypercoagulability, venous stasis, compressive syndromes, and vascular trauma.[2] Overall risk begins in the first trimester, peaks in the third trimester, and continues for at least 6 weeks postdelivery.[3] Pregnancy presents a unique challenge in the diagnosis of PE because many of the common signs and symptoms of PE, including dyspnea, tachycardia, and swelling, can also occur in a normal pregnancy. Therefore, having a high index of suspicion is important to make an appropriate diagnosis and institute and prompt therapy.

Our algorithm for PE patients includes both diagnostic and management considerations; however, each case

ALGORITHM CONSIDERATIONS FOR PE IN PREGNANT PATIENTS

Identify/diagnose the PE. The YEARS algorithm is recommended, as it can reduce number of CT scans used.
Assess patient risk category.
Collaborate with the cardio-obstetrics team and PERT to assist in decision-making.
Treat the PE based on risk, taking measures to reduce radiation when possible:

- Low-risk patients can generally be treated with anticoagulation alone (LMWH recommended due to its low fetal risks).
- Intermediate-risk patients are assessed for catheter- or surgical-based intervention and risk of hemodynamic decompensation. Select patients move on to catheter thrombectomy when appropriate.
- High-risk patients also assessed for catheter- or surgical-based intervention. ECMO is recommended when feasible, with debulking through catheter thrombectomy. Fibrinolytic therapy is crucial due to inherent bleeding risk in mother and fetus.

can be unique in its presentation and ultimate therapy. The YEARS algorithm can help in the initial diagnosis of PE.[4] This algorithm is PE specific and can reduce the number of CT scans used. Ultimately, CTA remains the gold standard for diagnosis and should be considered in pregnant patients despite the radiation risks. Most scanners used in the modern era use very little radiation and are safe for the fetus.

Once a PE is identified, we assess the patient's risk category. The European Society of Cardiology 2019 guidelines for acute PE divide patients into four major risk categories based on clinical, laboratory, and imaging parameters.[5] This guideline forms the basis of our algorithm to help guide treatment decisions, paying particular attention to the unique bleeding and radiation risks in pregnant patients. We previously published our algorithm in *JSCAI* in 2023.[6] An appropriate assessment of the right ventricle is key to establishing the patient's risk profile, as the main mechanism of mortality in acute PE is right heart failure. Hemodynamic parameters, oxygenation status, and cardiac biomarkers should also be assessed.

Anticoagulation is the mainstay of therapy in all PE patients. Those falling in the low-risk category can usually be treated via anticoagulation alone with heparin, with LMWH as the anticoagulant of choice due to its low fetal risks. Intermediate- and high-risk patients should be assessed for appropriateness of advanced therapy, including catheter- and surgical-based interventions. High-risk patients are those who are hemodynamically unstable and require emergent assistance. Fibrinolytic therapy should be used judiciously as there is an inherent bleeding risk to both mother and fetus.[7]

In high-risk patients, we advocate for hemodynamic stabilization with ECMO where feasible, with subsequent debulking through a catheter thrombectomy approach or, if not possible, surgery as a final option. Intermediate-risk patients should be assessed for their risk of hemodynamic decompensation, with selected intermediate- to high-risk patients moving on to catheter thrombectomy when appropriate. These therapeutic options in pregnancy have not been studied in large patient populations, as literature on this population is limited to case reports. When available, PERTs can greatly assist in the complex decision-making process for these patients in conjunction with a cardio-obstetrics team.[8,9]

Radiation must absolutely be taken into consideration in the pregnant patient. The radiation risk to the fetus is highest in the first trimester and decreases over the course of the pregnancy. Fortunately, most diagnostic and interventional imaging modalities can be performed at well under 5 mSv, with many being < 1 mSV. This is well below the threshold of 50 mSV. Below this threshold, no fetal abnormalities have been detected. However, if a pregnant patient is undergoing a procedure, standard measures to reduce radiation should be considered, including using "fluoro save" instead of cine, collimation, and abdominal shielding for the fetus.[6]

The management of a pregnant patient with PE can be complex. However, working as a team, we can provide prompt and accurate diagnosis leading to appropriate intervention and successful outcomes for these patients. In our center, we have developed close multidisciplinary relationships among members of maternal-fetal medicine, labor and delivery, the cardio-obstetrics

team, and our PERT. Through case reviews, conferences, and open communication, we foster ongoing collaboration among our sections and encourage other centers to do the same. We have found it incredibly rewarding and important to help in the care of our patients. ■

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