JOINT CONSENSUS STATEMENT

VENOUS THROMBOEMBOLISM IN PREGNANCY

RECOMMENDATIONS FOR PREVENTION, TREATMENT AND INVESTIGATION

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ACADEMY OF MEDICINE SINGAPORE

COLLEGE OF OBSTETRICIANS & GYNAECOLOGISTS, SINGAPORE

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INTRODUCTION

Venous thromboembolism (VTE) includes both deep vein thrombosis (DVT) and pulmonary embolism (PE). The risk of thrombosis increases ten-fold in pregnancy, due to the physiological increase in clotting factors, the compressive effect of the gravid uterus on pelvic veins and the pelvic vascular endothelial injury which accompanies delivery. Pulmonary embolism is one of the leading causes of direct maternal deaths worldwide, including Singapore. DVT is also not without significant morbidity as it can lead on to the development of post-thrombotic syndrome and chronic venous ulcers. Thromboprophylaxis for prevention of VTE in pregnancy should therefore be made a priority as VTE is largely preventable if appropriate measures are taken.

The incidence of VTE is thought to differ by race with the highest incidence in Blacks, then Whites, and lowest among Asians and Hispanics.[1, 28] However, few studies have been able to appropriately evaluate the race-VTE association whilst controlling for appropriate confounders, and so the association between race and VTE remains controversial. There is a growing body of evidence that VTE is not as uncommon as previously thought among Asians, and that the perceived rarity of VTE has resulted in gross under-diagnosis of the condition.[2] A study from Hongkong found a VTE incidence of 1.88 per 1000 deliveries among Chinese women from 1998 to 2000, and 75% of these cases occurred in the postpartum period and after caesarean sections.[3] The types of thrombophilia that are more prevalent and more likely to contribute to VTE in Asian populations also differ from that of Western populations. Studies have shown that there is a higher prevalence of congenital thrombophilia such as anti-thrombin, protein C and Protein S deficiencies in the Chinese, whereas in the West factor V Leiden and prothrombin gene mutations are more prevalent.[4-6]

There is currently a paucity of high-quality evidence in the literature with regard to VTE prevention in pregnancy, and insufficient evidence to recommend universal adoption of thromboprophylaxis for VTE. Thromboprophylaxis should therefore be individualized according to the individual patient's risk factors (risk stratification). Although there is no clear evidence derived from high quality studies, consensus-derived clinical practice guidelines can be based on indirect evidence to guide clinical management.

This consensus statement was commissioned by the College of Obstetricians and Gynaecologists, Singapore and the College of Physicians (Chapter of Haematologists), Singapore to specifically address the prevention and treatment of VTE in pregnancy and has taken into consideration information from major international guidelines[7-13] and evidence from recent studies. It aims to address specific issues and will be updated further if new evidence becomes available.

THROMBOPROPHYLAXIS FOR VTE IN PREGNANCY

We recommend the following risk assessment for VTE in pregnancy:

- All women should undergo a documented assessment of risk factors for VTE in early pregnancy or as part of pre-conception counselling. (Grade C)
- Risk assessment for VTE should be repeated for any antenatal admission to hospital, inter-current problems and in the immediate postpartum period. (Grade C)
- Women with history of inherited thrombophilia should be managed in conjunction with haematologists. These women should undergo detailed history taking of personal and family history of VTE to assess for risk of VTE during pregnancy and need for thromboprophylaxis. (GPP)
- Consideration for prophylactic Low Molecular Weight Heparin (LMWH) in the antenatal and postnatal period should be given in accordance to the recommendations based on the individual risk scoring based on the VTE risk assessment tool below. (Grade D)

N.B.

1. International consensus guidelines provide general guidance on thrombophilia screening, but patterns of hereditary thrombophilia are influenced by geographical regions and ethnic composition. Studies done on non-pregnant patients demonstrate that protein C, protein S and antithrombin deficiency are more prevalent thrombophilic markers in Asian patients, than that of Factor V Leiden and prothrombin gene mutation when compared with Caucasian populations.[4-6, 14]. This is consistent with local data that also report higher rates of protein C, protein S and anti-thrombin deficiencies.[15] These three deficiencies have also been shown to be potentially more thrombogenic than that of Factor V Leiden or prothrombin gene mutation.[16.] Data from these studies have been taken into consideration and extrapolated to pregnant patients in this consensus statement.
2. Diagnostic tests for thrombophilia should not be performed during pregnancy. Protein S levels may be falsely low during pregnancy secondary to increased complement binding. A previous history of isolated low protein C, protein S or antithrombin level is also not diagnostic of thrombophilia and should be repeated when patient is not pregnant.

Risk Assessment for Venous Thromboembolism (adapted from RCOG Greentop Guideline

Antenatal Thromboprophylaxis

- If total score ≥ 4 antenatally, consider thromboprophylaxis once pregnancy is diagnosed.
- If total score 3 antenatally, consider thromboprophylaxis from 28 weeks (third trimester).
- If admitted to hospital antenatally, consider thromboprophylaxis.

Postnatal Thromboprophylaxis

- All women requiring antenatal LMWH will require at least 6 weeks of prophylactic postnatal LMWH.
- If total score ≥ 2 postnatally, consider thromboprophylaxis with LMWH for at least 7 days.
    - If these risk factors persist beyond 7 days, consider extended thromboprophylaxis
- If total score ≥ 3, consider extended thromboprophylaxis with LMWH up to 6 weeks.
- If readmission to hospital within the puerperium, consider LMWH thromboprophylaxis.

Additional notes:

1. For patients with an identified bleeding risk, the balance of risks of bleeding and thrombosis should be discussed in consultation with haematologist.
2. If the woman is not suitable for or declines pharmacological thromboprophylaxis, consider mechanical thromboprophylaxis (intermittent pneumatic compression devices/graduated compression stockings) as an alternative although data on these are limited.
3. VTE risk assessment during pregnancy should be dynamic. Clinical judgement should be applied when considering prophylactic anticoagulation for any new VTE risk factor that may develop during the course of pregnancy.
4. Women on thromboprophylaxis for transient VTE risk factors should be reassessed once these risk factors have resolved.

Risk factors for VTE (adapted from RCOG Greentop Guideline 37a)

	Tick	Score
VTE history		
Previous unprovoked VTE and estrogen-related VTE		4
Previous non-estrogen provoked VTE		3
Family history of unprovoked or estrogen-related VTE in first-degree relative		1
Inherited thrombophilia		
Known high-risk thrombophilia: Antithrombin deficiency		4
Known high-risk thrombophilia: Protein S deficiency Protein C deficiency Homozygous factor V Leiden mutation Homozygous prothrombin gene mutation Compound heterozygote (factor V Leiden/prothrombin gene mutation)		3
Known low-risk thrombophilia (no VTE): Heterozygous prothrombin gene mutation Heterozygous factor V Leiden mutation Persistent antiphospholipid antibodies (anti-cardiolipin antibodies, lupus anticoagulant, β2 glycoprotein 1 antibodies) without any clinical features of antiphospholipid syndrome		1[a]
Existing risk factors		
Medical comorbidities e.g. cancer, heart failure, active systemic lupus erythematous, inflammatory polyarthropathy or active inflammatory bowel disease Type 1 diabetes mellitus with nephropathy Sickle cell disease Current intravenous drug user		3
Obesity BMI 30-39.9 BMI ≥ 40		 1 2
Parity ≥ 3		1
Smoker		1
Age > 35 years (postnatal assessment only)		1
Obstetric risk factors		
Pre-eclampsia in current pregnancy		1
ART/IVF (antenatal assessment only)		1
Multiple pregnancy		1
Elective caesarean section		1
Emergency caesarean section		2
Prolonged labour (>24 hours)		1
PPH (>1 L or transfusion required)		1
Preterm birth <37+0 weeks in current pregnancy		1
Stillbirth in current pregnancy		1
Transient risk factors		
Any major surgical procedure in pregnancy or puerperium (excluding caesarean section)		3
Hyperemesis (as defined by PUQE score)		3
OHSS (1st trimester only)		4
Current systemic infection		1
Immobility		1
Dehydration		1

[a] *If the known low-risk thrombophilia is in a woman with a family history of VTE in a first-degree relative, postpartum thromboprophylaxis should be continued for 6 weeks.*

N.B. The above risk assessment tool was adapted from the RCOG Greentop Guideline 37a, with main changes made to risk score assigned to antithrombin deficiency and advanced maternal age. Justifications for maintaining antithrombin deficiency, protein S and protein C deficiency as high-risk thrombophilia are discussed below.

1. A study looking at the absolute risks of first venous thrombosis in asymptomatic relatives with antithrombin deficiency found the annual incidence of venous thrombosis to be 1.77%.[16] This was significant compared to the annual incidence of first venous thrombosis in asymptomatic relatives with Factor V Leiden and Prothrombin gene mutation which was 0.49% and 0.34% respectively.[16] Similarly, another paper reported antithrombin deficiency to be the most severe of inherited thrombophilia, with a 50 fold increased risk of VTE compared to individuals without the defect.[17] Pregnant women with antithrombin deficiency remain at risk of venous thrombosis antepartum and postpartum despite anticoagulation, supporting the use of thromboprophylaxis in these patients.[18,19] Considering the above, the committee came to the consensus that antithrombin deficiency should be given a risk score of 4 and this risk factor alone would justify initiation of thromboprophylaxis.

2. There is compelling data that shows in Asian populations, protein C and protein S deficiencies are more prevalent when compared to Caucasian populations, and with significant rates of incidence of first and recurrent venous thrombosis.[5-6, 14] Data from Asian and Caucasian studies have also showed that compared to heterozygous FV Leiden and heterozygous prothrombin gene mutation, patients with protein C and protein S deficiencies have a higher risk of VTE.[14,17] However worldwide incidences of these thrombophilia still remain lower than that of commoner thrombophilia such as Factor V Leiden and prothrombin mutation.[16] Currently, more Asian data is required to determine the clinical significance and risk stratification of these thrombophilia. Clinicians are encouraged to consider the individual's personal history and risk factors and family history in making a decision for thromboprophylaxis for these patients. Patients with Protein S or Protein C deficiency and additional VTE risk factors such as family history of VTE should be considered for antenatal and postpartum prophylaxis (up to 6 weeks postpartum).

3. Advanced maternal age more than 35 years of age as a risk factor for thrombosis has been included only as part of the postnatal assessment for thromboprophylaxis. Data in the current literature pertaining to age as a risk factor for thrombosis in the current literature are conflicting. A recent local study was conducted to examine risk factors for pregnancy-associated venous thromboembolism over a 12-year period from 2004 to 2016 at 2 tertiary maternity hospitals, looking at 89 women with pregnancy-associated VTE and 926 controls.[20] The study found that age more than or equal to 35 years of age was not a statistically significant risk factor for thrombosis (OR 1.33, 95% CI 0.64-2.82, p-value 0.459). A Korean study similarly found that increased age was not associated with VTE in pregnancy.[21] However, a large UK population-based cohort study found that outside of pregnancy, women in the oldest age band (35–44 years) had a 50% higher rate of VTE than women aged 25–34 years.[22] However, the study also found that although the rate of VTE did not increase with age in the antepartum period, women aged 35 and over had a 70% increase in risk compared to 25–34-year-olds in the postpartum period. Based on the available evidence, the committee thus decided to use age as a risk factor for thrombosis only in the postnatal risk assessment for thrombotic risk.

We recommend the following thromboprophylaxis agents and doses for prevention of VTE in pregnancy:

- Women requiring thromboprophylaxis during pregnancy should be counselled of the possible therapeutic options including potential side effects to both mother and fetus. (GPP)
- Low molecular weight heparins are the agents of choice for antenatal and postnatal thromboprophylaxis. (Grade A)
- LMWH doses are based on weight (either booking weight or most recent weight). (Grade B)
- Monitoring of platelet counts after initiation of LMWHs for thromboprophylaxis is only necessary if the woman has had prior exposure to unfractionated heparin (UFH). (Grade B)
- LMWH doses should be reduced in women with renal impairment. The degree of dose reduction can be decided in consultation with haematologist. (Grade C)
- Women with a history of VTE associated with high-risk thrombophilia (e.g. protein S deficiency, protein C deficiency, anti-thrombin deficiency) or anti-phospholipid syndrome should be considered for higher doses of LMWH (50%-100% of therapeutic dose) antenatally and for 6 weeks postpartum or until return to oral anticoagulation therapy. These women should be co-managed with haematologist. (Grade D)

- Women on long-term anticoagulation for secondary prevention of VTE should continue on full treatment dose during the course of pregnancy. (Grade D)
- Suggested thromboprophylactic doses for antenatal and postnatal LMWH for all other women are shown in the chart below (adapted from RCOG Greentop Guidelines 37a):

Weight	Enoxaparin	Dalteparin	Nadroparin (Fraxiparine)
<50 kg	20 mg daily	2500 units daily	
50 – 90 kg	40 mg daily	5000 units daily	0.3ml daily (2850 units)
91 – 130 kg	60 mg daily	7500 units daily	
131 – 170 kg	80 mg daily (or 40mg BD)	10000 units daily	
>170 kg	0.6 mg/kg/day	75 units/kg/day	

**These doses are recommended doses for patients with normal renal function. Patients with renal impairment may require dose adjustment depending on the severity of renal dysfunction.*

We recommend the following with regard to mechanical thromboprophylaxis in the antenatal period:

- Mechanical thromboprophylaxis includes the use of graduated compression stockings (GCS) (with pressure of 14-15 mmHg at the calf) and intermittent pneumatic compression (IPC) devices that work by reducing venous stasis. (Grade D)
- IPC and/or GCS should be considered if hospitalized, especially if for more than 3 days.[22] (GPP)
- Patients at high risk for VTE but have contraindications to pharmacological thromboprophylaxis should be considered for mechanical thromboprophylaxis.[7] However, data supporting this in the antenatal population is limited. (GPP)

We recommend the following with regard to thromboprophylaxis during labour and delivery, including the use of regional analgesia (GPP):

- Women receiving antenatal LMWH should be advised to stop LMWH if they have any vaginal bleeding or symptoms and signs of labour.
- Regional analgesia should be avoided until at least 12 hours after the last dose of LMWH. However, in women with renal impairment, it would be advisable to wait for at least 24 hours after the last dose of LMWH before administration of regional analgesia.

- LMWH should not be given until 4 hours have elapsed after spinal anaesthesia or after the epidural catheter has been removed.
- The epidural catheter should not be removed within 12 hours of the most recent prophylactic dose of LWMH injection.
- Prior to resuming anticoagulation, ensure that patient has achieved adequate haemostasis, has had complete neurological recovery, has no coagulopathy, has normal renal function and is not assessed to be at high risk of postpartum haemorrhage. If there are no contraindications to resuming anticoagulation, the first thromboprophylactic dose of LMWH should be given 4 to 6 hours after delivery, taking into account the risk of postpartum haemorrhage.
- If the postpartum bleeding risk is high and the woman is hence deemed unsuitable for early LMWH administration after delivery, intermittent pneumatic compression (IPC) or graduated compression stockings (GCS) may be offered as an alternative although data supporting this practice is weak.

We recommend the following with regard to mechanical thromboprophylaxis for caesarean deliveries (GPP):

- Patients at high risk of VTE and undergoing caesarean section should be prescribed a combination of LMWH and GCS and/or IPC. If there are contraindications to LMWH, GCS and/or IPC should be prescribed.[23-26] This is based on evidence extrapolated from studies on non-pregnant population.
- The use of knee-length GCS is recommended over thigh-length GCS as the former is associated with a higher adherence rate and a lower risk of adverse effects such as skin breaks.[27]

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TREATMENT OF VTE IN PREGNANCY

We recommend the following for antenatal treatment of VTE in pregnancy:

- Women diagnosed with VTE during pregnancy should be counselled of the possible therapeutic options including potential side effects to both mother and foetus.[1] (GPP)
- Both unfractionated heparin (UFH) and LMWH do not cross the placenta and hence are not associated with risk of teratogenicity or fetal bleeding.[1-3]
- LMWH is the anticoagulant of choice in the treatment of VTE in pregnancy.[1-7,8] (Grade B)
    - LMWH has greater ease of administration, lower risk of osteoporosis, reduced rates of bleeding and lower risk of heparin-induced thrombocytopenia (HIT) compared to UFH.[4]
- Vitamin K Antagonists should be avoided in the antenatal period unless under exceptional circumstances.[2-5,9] (Grade C)
    - Vitamin K antagonists have the potential to cross the placenta, leading to warfarin embryopathy in the form of mid-facial and limb hypoplasia and stippled bone epiphyses.
    - Warfarin has also been associated with loss of pregnancy, fetal anticoagulation and bleeding.
- Direct oral anticoagulants (DOACs) are not recommended in the antenatal period.[1-4,10] (Grade D)
    - DOACs have the potential to cross the placenta and lead to teratogenic effects. There is a lack of safety data of DOACs in pregnancy.
- In the event of heparin-induced thrombocytopenia (HIT) (less than 0.1% risk in the obstetric population) or heparin allergy, the patient should be managed in conjunction with a haematologist.[11] (GPP)
- The placement of temporary IVC filters should only be considered in patients with recent proximal DVT who have an absolute contraindication to anticoagulation due to high bleeding risk or in patients who have recurrent VTE despite adequate anticoagulation. The IVC filter should be removed as soon as it is safe to resume anticoagulation.[2,7] (Grade D)
- Early ambulation should be encouraged as it can reduce pain associated with acute DVT and does not cause progression of DVT or increase the incidence of PE.[4,12-14] (Grade B)
- GCS or compression therapy may be prescribed in acute DVT for the purpose of reducing pain and edema.[4,15] (Grade B)

We recommend the following therapeutic dosing of LMWH in pregnancy:

- LMWH should be titrated against patient's booking or early pregnancy weight.[4] (Grade C)
- LMWH dose reduction should be considered in women with renal impairment in consultation with haematologist. (GPP)
- There is currently insufficient evidence on the safety of reducing LMWH dose from therapeutic to an intermediate dose after an initial period of anticoagulation and hence should be discouraged.[4] (Grade B)

We recommend the following duration of anticoagulation for VTE in pregnancy:

- Patients with VTE in pregnancy should be anticoagulated with therapeutic doses of anticoagulants for the duration of pregnancy up to at least 6 weeks postpartum, AND for a total of 3 months minimum.[4] (Grade C)
    - The relative risk of VTE postpartum increases 5-fold when compared to the antepartum period, this risk being the highest in the first 3 weeks postpartum.[16,17]
- Patients should undergo another VTE risk scoring prior to cessation of anticoagulation.[4]

We recommend the following treatment for life and limb-threatening VTE in pregnancy:

- Patients with life and limb threatening VTE should be managed with a multidisciplinary team. Systemic thrombolytic therapy in addition to anticoagulant therapy should be considered for patients with limb threatening DVT or life-threatening PE with haemodynamic instability.[1-7] (GPP)
- Intravenous UFH is the preferred initial anticoagulant in patients with massive PE with cardiovascular compromise due to its rapid onset and allowance for dose adjustment.[4] (Grade B)

We recommend the following with regard to laboratory monitoring of patients on LMWH:

Anti-Xa monitoring for patients on LMWH:

- There is currently no good data to recommend monitoring of anti-Xa levels nor is there a validated reference range for target anti-Xa levels in pregnant patients on LMWH. Routine monitoring of anti-Xa levels should not be performed except for in the following situations:[3,4] (Grade C)
    - Extremes of weight (less than 50kg or more than 90kg)
    - Development of recurrent VTE despite being on therapeutic dose LMWH
    - Renal impairment with a eGFR of less than 30ml/min
    - Suspicion of non-compliance to LMWH

- For patients that require anti-Xa level monitoring, the monitoring and subsequent dose adjustment of LMWH should be done in conjunction with a haematologist. (GPP)

Platelet count monitoring:

- Consider platelet count monitoring when risk of HIT is higher such as in the following situations:[4,18]
    - Prior LMWH or UFH exposure in the past 100 days: check platelet counts 24 hours after initiation of LMWH or UFH. (GPP)
    - Postoperative obstetric patients receiving UFH: monitor platelet counts every 2 to 3 days from day 4 to 14, or until UFH is stopped. (Grade D)

We recommend the following with regard to the peri-partum management of anticoagulation during labour and delivery, including the use of regional analgesia:

- Anticoagulation and delivery plans should be made in conjunction with the anaesthetist. The patient should also be adequately counseled on plans for cessation of anticoagulation prior to labor and delivery.[2] (GPP)
- The appropriate mode of delivery should be determined by obstetric indications. For ease of control of anticoagulation and to minimize time off anticoagulants, a planned date and mode of delivery i.e. induction of labor for normal vaginal delivery or a scheduled Caesarean section is recommended.[2,5-6] (GPP)
- Women receiving antenatal LMWH should be advised to stop LMWH if they have any vaginal bleeding or symptoms and signs of labour. Regional analgesia should be avoided until at least 24 hours after the last dose of LMWH.[2,4,5,7] (Grade D)
- Patients at very high risk of thrombosis may require UFH during labour and should be managed in conjunction with a haematologist. (GPP)
- LMWH should not be given until 4 hours has elapsed after use of spinal anaesthesia or after epidural catheter removal. The epidural catheter should not be removed within 12-24 hours of the most recent therapeutic dose of LMWH injection.[4] (Grade D)
- Prior to resuming anticoagulation, ensure that patient has achieved adequate haemostasis, has had complete neurological recovery, has no coagulopathy, has normal renal function and is not assessed to be at high risk of postpartum haemorrhage.[2] (GPP)
- If there are no contraindications to resuming anticoagulation, a prophylactic dose of LMWH can be administered once 4 to 6 hours after delivery.[4,7] The prophylactic dose of LMWH should be followed by a therapeutic dose of LMWH within 24 hours post-delivery depending on the risk of bleeding.[7] Overlapping oral anticoagulation should be withheld when escalating LMWH from prophylactic to therapeutic dose within the first 24 hours. (Grade D)

We recommend the following with regard to the postpartum anticoagulation:

- Patients should be offered the option of either LMWH or oral anticoagulation in the postpartum period.[4] (GPP)
- LMWH is the preferred choice of anticoagulant due to the lack of need for regular blood tests and dose adjustments. (GPP)
- Both LMWH and warfarin do not accumulate in breast milk and are compatible with breastfeeding.[1,4] (Grade D)
- Patients who are not breastfeeding can be offered DOACs as an alternative oral option.[4] (Grade D)
- Patients who opt for warfarin should not be started on warfarin until the fifth day postpartum or even later in women who are at higher risk of postpartum hemorrhage.[4] They should receive bridging LMWH until the INR has reached therapeutic levels of between 2 and 3. They should also be counselled that it may take up to 2 weeks for INR levels to stabilise and might hence require frequent INR checks till then.[1] (GPP)

We recommend the following with regard to the role of GCS in prevention of post-thrombotic syndrome:

- A Cochrane review previously reported that the use of GCS in the non-pregnant population reduced the risk of PTS significantly and that using it for two years was more effective than one year.[19] However, recent studies in the non-pregnant population showed that the routine use of GCS for two years did not reduce the likelihood of developing PTS, the incidence of severe PTS or the recurrence of DVT.[20,21]
- Routine use of GCS for risk reduction of PTS is not recommended. However, GCS may be used when necessary for temporary relief of discomfort caused by leg swelling and pain. (Grade B)

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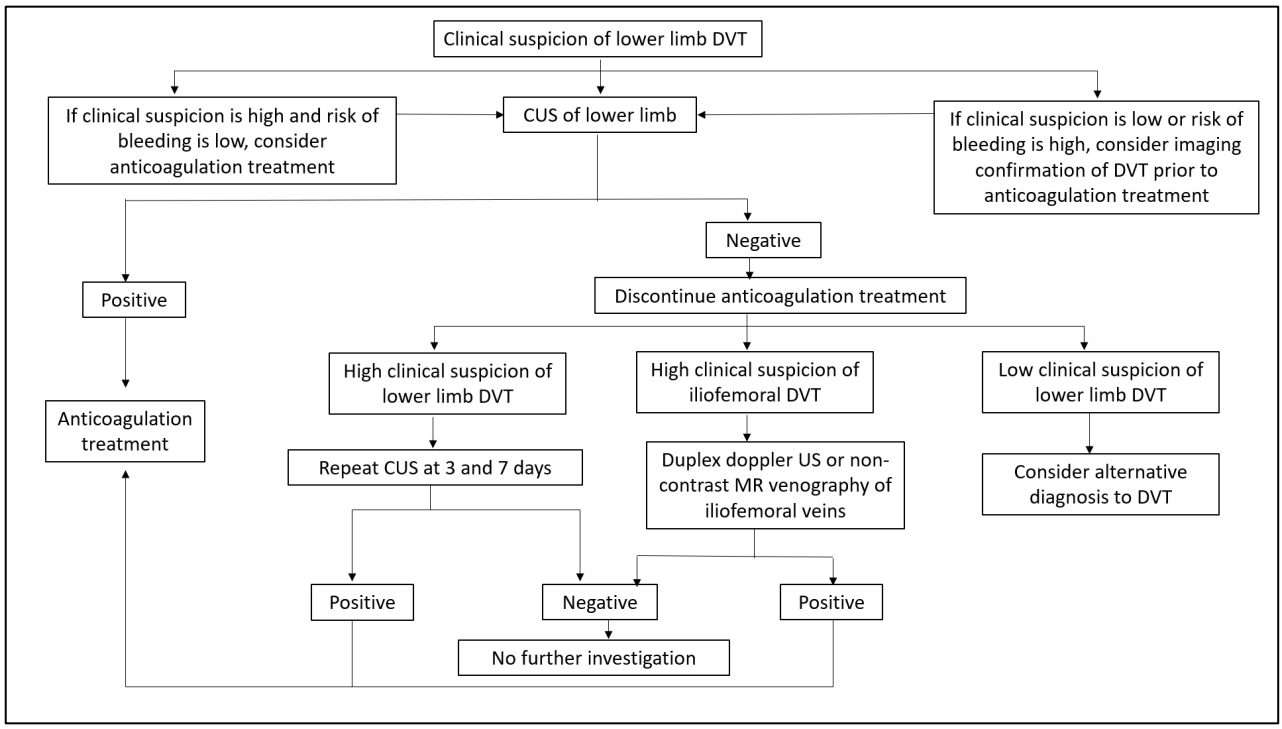
DIAGNOSTIC IMAGING OF SUSPECTED VTE IN PREGNANCY

We recommend the following imaging algorithm for suspected acute deep vein thrombosis in pregnancy.

- Compression duplex ultrasound (CUS) is the first line imaging modality of choice in the investigation of suspected lower limb DVT.[1-4] (Grade B)
- For patients with an initial negative study but with a high clinical suspicion for lower limb DVT, serial CUS at days 3 and 7 should be performed to detect proximal extension of distal thrombus.[1-4] (Grade C)
- In pregnant women where the initial CUS is negative but with a high clinical suspicion for iliofemoral DVT, further evaluation with iliac vein duplex doppler ultrasound (US) is often sufficient given the extensive nature of the thrombosis.[1-4] (Grade D)

Imaging algorithm for suspected acute deep vein thrombosis in pregnancy



DVT = deep vein thrombosis; CUS = compression duplex ultrasound; US = ultrasound; MR = magnetic resonance

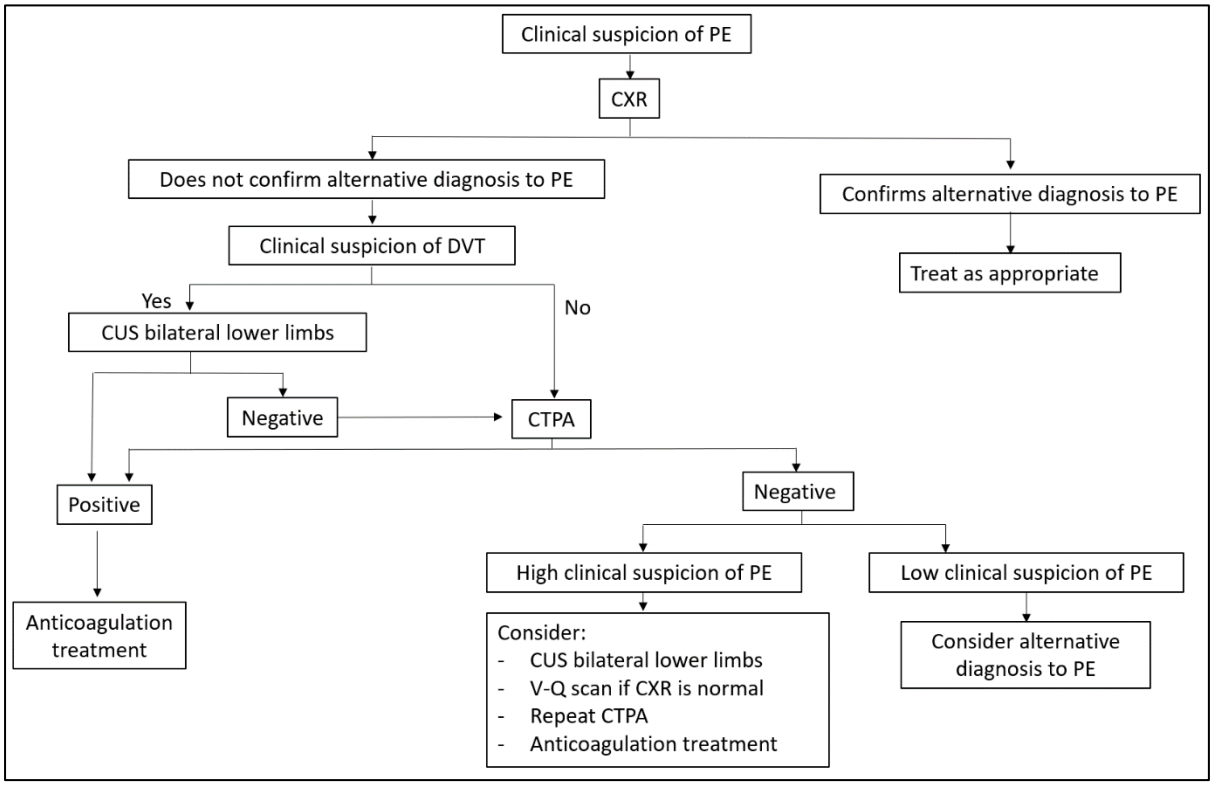
We recommend the following imaging algorithm for suspected pulmonary embolism in pregnancy:

- Chest radiograph (CXR) has a negligible radiation dose and is recommended as the initial investigation for patients with symptoms of pulmonary embolism (PE).[2] (Grade C)
- CUS of both lower limbs is recommended in patients with suspected PE who also have symptoms of DVT. If CUS confirms a diagnosis of DVT, treatment can be commenced with no need of further investigation for PE.[2,5] (Grade C)
- Computed tomography pulmonary angiography (CTPA) is considered the imaging modality of choice for the diagnosis of PE.[6] (Grade D)
- Ventilation-perfusion scintigraphy (V-Q scan) is an appropriate modality for further investigation in patients with a normal CTPA and persistent high clinical suspicion of PE.[7] (Grade D)
- V-Q scan is an appropriate alternative modality for patients who are unable to undergo CTPA, for example patients with renal failure or allergy to contrast material and patients who cannot fit into the CT scanner.[8] (Grade D)

N.B.

1. When investigating pregnant women with suspected PE, the risks from ionizing radiation exposure to the developing foetus and mother and benefits of diagnostic imaging need to be addressed and informed consent obtained.
2. CTPA performed on currently available 2nd and 3rd generation dual source CT scanners have been shown to produce comparable maternal radiation doses to a V-Q scan with both modalities producing foetal radiation doses of less than 1 mGy.[5,9]
3. The current imaging recommendations are based on the assumption that CTPA does not pose a significant increased risk of radiation exposure to maternal breasts when compared with V-Q scan.
4. Foetal exposure to radiation doses of less than 1 mGy are comparable to the dose received annually from natural background radiation and considered to pose a negligible risk.[10]
5. The risks of radiation exposure from diagnostic imaging of suspected PE is relatively small compared to that of an undiagnosed and untreated PE which is associated with a mortality risk of 30%.[11]

Imaging algorithm for suspected pulmonary embolism in pregnancy



PE = pulmonary embolism; CXR = chest radiograph; CUS = compression duplex ultrasound; CTPA = computed tomography pulmonary angiography; V-Q scan = ventilation-perfusion scintigraphy

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