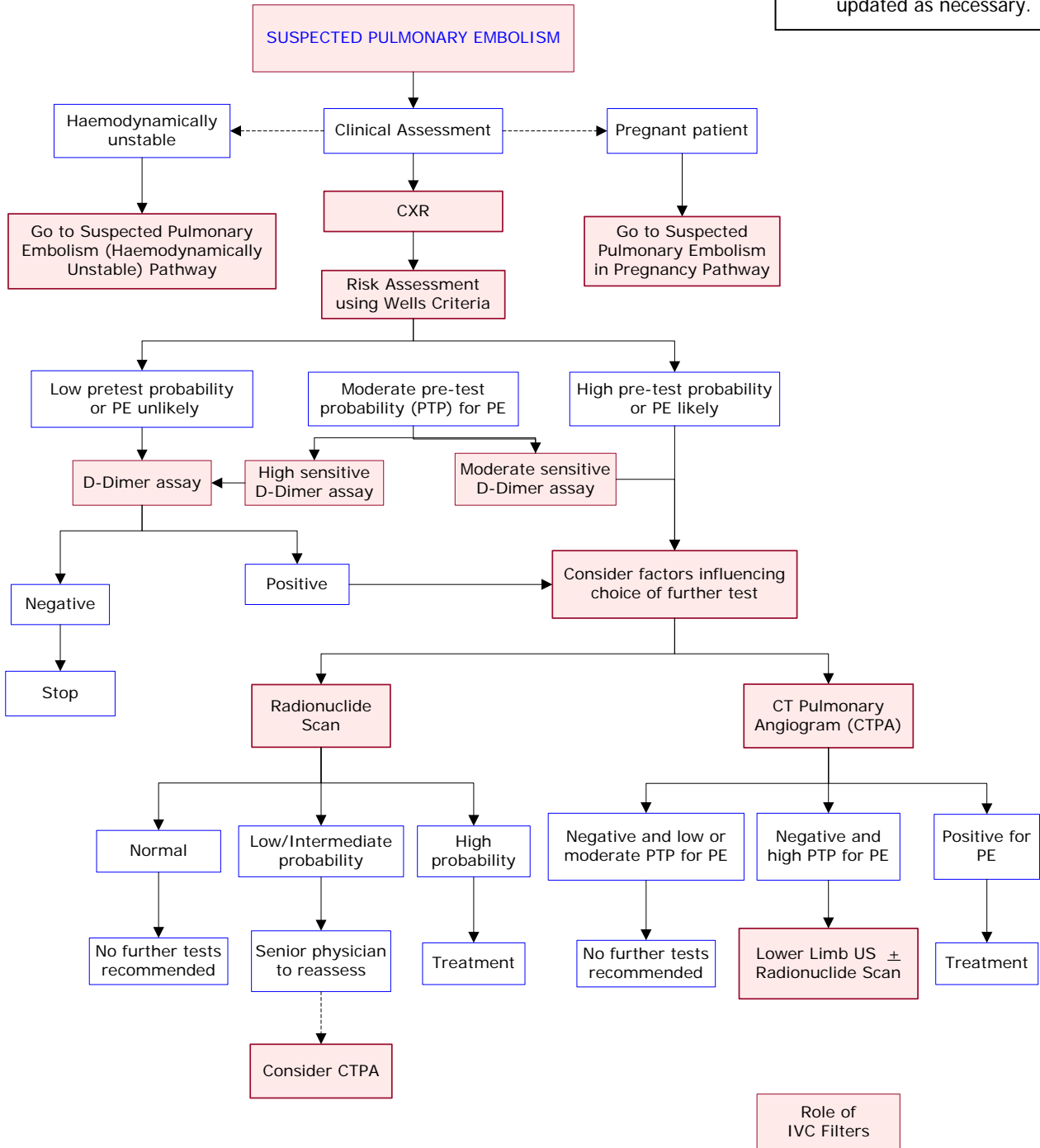




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Pathway last reviewed August 2010. Pathways will be reviewed periodically and updated as necessary.



PLAIN CHEST RADIOGRAPHY

- Mainly useful for excluding conditions that can mimic pulmonary embolism. [18](#)
- Features: [19](#)
 - Only approximately 12% of patients with angiographically proven PE have a normal CXR.
 - The most common CXR findings with PE are atelectasis and parenchymal opacities in the affected lung zone.
 - Oligaemia was the only CXR finding that occurred significantly more frequently in patients with PE compared to those without.
 - Positive predictive value of a normal CXR: 18%
 - Negative predictive value of a normal CXR: 74%
- The other main use of a CXR is to assist in determining whether a VQ or a CTPA is the most appropriate next investigation.
 - Patients with an abnormal CXR are more likely to have a non-diagnostic VQ scan than those with a normal CXR. [20](#)
 - CT Pulmonary Angiography should therefore be used ahead of VQ in these patients. [20](#)

CLINICAL PREDICTION RULES FOR PRETEST PROBABILITY OF PULMONARY EMBOLISM

- Clinical prediction rules are now well accepted as key components in the diagnostic approach to pulmonary embolism. The posttest probability of PE depends not only on the accuracy of the test but also on the pretest probability as determined by these prediction rules. [41,42](#)
- The Wells Criteria is extensively validated and effectively triages patients into three pretest probability groups based on the following clinical variables: [23-24](#)
 - Clinical signs and symptoms of deep venous thrombosis (leg swelling and deep venous pain): 3 points.
 - PE as or more likely than an alternative diagnosis: 3 points.
 - Previously objectively diagnosed DVT or PE: 1.5 points.
 - Active cancer (less than 6 months since therapy or palliative stage): 1 point.
 - Recent Immobilisation: 1.5 points
 - Bedrest for at least 3 consecutive days.
 - Surgery in the previous 4 weeks.
 - Heart rate greater than 100 per minute: 1.5 points.
 - Haemoptysis: 1 point.
- Total Score: 0-1 = Low, 2-6 = Intermediate, 7+ = High probability

- There are other clinical prediction rules like the two-category Wells criteria(which classifies patients into PE likely or unlikely) [43-45](#) and the Geneva score [46](#). These have also been validated. [42](#)
- Whichever rule is used, the proportion of patients with PE is around 10% in the low probability category, 30% in the moderate probability category and 65% in the high clinical probability category. [41, 42](#)

D-DIMER ASSAY

- D-Dimer is formed as a result of plasmin generated degradation of thrombin and is therefore a marker of the presence of thrombus.
- There are various qualitative and quantitative assays available for D-dimer, but in general they have a high sensitivity and negative predictive value for the presence of thrombus. [26,27](#)
- Of the various assays, the quantitative enzyme linked immunosorbent assay (ELISA) has the best negative likelihood ratio and is significantly superior to non-ELISA assays for excluding the presence of pulmonary embolism (sensitivity >90%, specificity 40%). [28, 29, 41](#)
- A negative quantitative ELISA D-dimer result is as diagnostically useful for excluding PE as a normal helical CT lung scan. [28](#)
- A negative D-dimer result in a highly sensitive assay (e.g. ELISA) safely excludes PE in patients with a low or moderate clinical probability [28, 29](#) while a moderately sensitive assay excludes PE only in patients with a low clinical probability [41](#)
- When using the dichotomous clinical prediction rule(which classifies patients as PE unlikely and PE likely), a negative D-dimer result is able to exclude PE safely in PE-unlikely patients either by a highly sensitive or moderately sensitive assay. [41](#)

RADIONUCLIDE LUNG SCAN

- Lung perfusion images are taken after the intravenous injection of technetium-99m macroaggregated albumin. A PE characteristically appears as a pleural based segmental perfusion defect. [1](#)
- Any perfusion defects are compared to ventilation images and any regions of mismatch are considered suspect for PE. [1](#)
- Ventilation perfusion scans, compared to CTPA, are associated with significantly lower radiation exposure by a factor of 7-9. The effective dose of a VQ scan is estimated at 1.3 mSv, compared to around 8-10 mSv for CTPA. [31,32](#)
- The radiation exposure is of particular importance to young females with breast tissue that has a higher turnover rate, who are therefore most susceptible to radiation-induced carcinogenesis. The absorbed dose to the breast tissue by CTPA is 30-40 times greater compared to a perfusion

scan. The Biological Effects of Ionizing Radiation, seventh report (BEIR VII) estimates that the lifetime attributable risk of breast cancer from a breast dose of 20mGy is approximately 1/1200 for a woman aged 20, 1/2000 for a woman age 30 and 1/3500 for a woman aged 40. [38](#) The lifetime risk of breast cancer for women is approximately 1/8. A radionuclide lung scan is therefore recommended, where available and appropriate, as the first line investigation in young women who are at risk of pulmonary embolism. [31-34](#)

- Has the following diagnostic features: [21](#)
 - A high-probability scan usually indicates PE but only a minority of patients with PE have a high probability scan.
 - A low-probability scan combined with a low pre-test probability of PE makes a PE very unlikely.
 - An intermediate-probability scan is not usually helpful in establishing a diagnosis. Patients with a intermediate-probability scan (or low-probability scan with a high pretest probability) should be reviewed and considered for further testing with a CTPA if there is persisting clinical suspicion for PE.
- Limitations:
 - Frequent non-diagnostic results, particularly for patients with an abnormal chest x-ray or a significant history of chronic obstructive lung disease. [20](#)
- Advantages:
 - Lower radiation exposure compared to CT Pulmonary Angiography.
 - Widely available.
 - A normal scan useful for excluding PE in the majority of patients. [21](#)

COMPUTED TOMOGRAPHY PULMONARY ANGIOGRAPHY (CTPA)

- Demonstrates a pulmonary embolism by showing a filling defect within contrast filled pulmonary arteries.
- CT Pulmonary Angiography is associated with significantly higher radiation exposure compared to Radionuclide (VQ) scans. The effective dose of CTPA is estimated at around 8-10 mSv, compared to around 1.3 mSv for a VQ scan. [31,32](#)
- The radiation exposure is of particular importance to young females with breast tissue that has a higher turnover rate, who are therefore most susceptible to radiation-induced carcinogenesis.

The absorbed dose to the breast tissue by CTPA is estimated between 10-30mGy, which is 30-40 times greater compared to a perfusion scan. The Biological Effects of Ionizing Radiation, seventh report (BEIR VII) estimates that the lifetime attributable risk of breast cancer from a breast dose of 20mGy is approximately 1/1200 for a woman aged 20, 1/2000 for a woman age 30 and 1/3500 for a woman aged 40. [38](#) The lifetime risk of breast cancer for women is approximately 1/8. A Radionuclide lung scan is therefore recommended where available and appropriate, as the first line investigation in young women who are at risk of pulmonary embolism. [31-34](#)

- Studies using bismuth breast shields have shown radiation dose reductions of 34-57% to the breast, without significant decrease in image quality or diagnostic accuracy. [35-37](#)
- The role of CTPA in the diagnostic algorithm for PE is dependent to some degree on the type of scanner available:
 - Older scanners are limited by relatively long scan times and the associated respiratory motion artifact. [1](#)
 - Multi-slice CTPA has a number of advantages over older scanners that make it the central imaging modality for the investigation of PE at many centres.
 - High acquisition speed meaning larger volumes can be covered more quickly. [10](#)
 - Better detection of sub-segmental emboli. [11-15](#)
 - Better interobserver agreement rates. [11](#)
- The sensitivity and specificity for CTPA (single-slice) in acute pulmonary embolism is around 85%, with a negative likelihood ratio of 0.11. [29,30](#)
- The Prospective Investigation of Pulmonary Embolism Diagnosis II (PIOPED II) trial reported a sensitivity of 83% and specificity of 96% using mainly 4-row multi-detector CT(MDCT) without consistent use of bolus tracking contrast administration. Discordant CTPA and pre-test clinical risk stratification required further investigation. The negative predictive value of high risk patients with a negative CTPA was only 60% and the positive predictive value of patients at low risk with a positive CTPA was 58%. A relatively high rate (6%) of studies were non-diagnostic. [39](#)
- A recent randomised study by Righini, et al, compared one group who were assessed with d-dimer followed by multislice CTPA, to another group had d-dimer followed by lower limb venous ultrasonography and CTPA for exclusion of pulmonary embolism. Their primary outcome was the proportion of venous thromboembolic events in the 3-month follow-up period in each group in patients who were left untreated on the basis of the exclusion of pulmonary embolism by the

diagnostic strategy. They found no difference in the the 3 month thromboembolic risk between the groups (0.3% for each group respectively). Based on this evidence, pulmonary embolism can effectively be excluded with a negative CTPA in patients who have a low or moderate pretest probability. [40](#)

- CT is also able to provide information on alternative diagnoses that may mimic PE. [16,17](#)
- Limitations:
 - Lack of high quality evidence makes the diagnostic utility of single and multi-slice CTPA uncertain.
 - Radiation exposure.
 - Risk of contrast allergy and renal impairment.
 - Subject to interpretive pitfalls such as respiratory motion artifact, streak artifact and problems related to patient body habitus. [25](#)

LOWER LIMB DOPPLER ULTRASOUND

- The role of Doppler ultrasound in the evaluation of patients with suspected PE is controversial.
- Approximately 10% of patients with a PE will have an abnormal ultrasound and a further 2% will have evidence of DVT on serial scans. [22](#)
- May be useful if the pretest probability is discordant with the result of the VQ scan or CTPA. [22](#)
- Advantages:
 - Widely available.
 - Non-invasive.
- Limitations:
 - Low sensitivity for patients with PE.

ROLE OF IVC FILTERS

- Routine use of IVC filters is not recommended.
- Should be considered (preceded by pulmonary angiography) in patients with: [26](#)
 - Recurrent pulmonary emboli arising from lower limb or pelvis despite therapeutic anticoagulation.
 - Contraindication to anticoagulation.

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